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NEW AND NOTEWORTHY GASTEROMYCETES[1]

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(WITH 54 FIGURES)

This paper is based for the most part on hypogeous Gasteromycetes from the Pacific Northwest and specimens in the Farlow Herbarium, Harvard University. The last several seasons have been favorable for the collection of hypogeous fungi (both Ascomycetes and Basidiomycetes) in western Oregon and Washington. In 1937 the writer alone or in company with botanical colleagues procured 152 collections of hypogeous Gastromycetes in Oregon.

The specimens from the Farlow Herbarium were kindly loaned by Dr. D. H. Linder or Dr. G. D. Darker. Among them were several collections taken by the late Dr. R. Thaxter in the United States and South America, and which add materially to our knowledge of the Hysterangiales.

It has been the desire to present at one time illustrations of spores of the various species of *Melanogaster*. Therefore outline drawings of 12 species have been included to fill out unoccupied space in the plates.

I want to express thanks to Mrs. D. P. Rogers for her careful work in illustrating the paper, and to Dr. D. P. Rogers for critically editing the Latin diagnoses.

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Each species will be discussed separately except where new genera and families are involved, in which cases several species or genera may be treated in groups.

1. Rhizopogon exiguus sp. nov.

Fructificationes 2–10 mm. crassae, globosae vel irrigulares, spongiosae, superficie laevi, albae, cum maculis ochraceis, dein rubescentibus vel "snuff-brown"; fibrillis supra paucis, infra radiciformibus; peridio 200–400 μ crasso, hyphis magnis, hyalinis; gleba alba dein brunnea, siccitate "raw umber"; locellis subglobosis, parvis, maturitate sporis partim repletis; septa 60–70 μ crassis, hyphis magnis, hyalinis, contextis; basidiis tetrasporis, cylindriceis, 14–20 × 3–5 μ; sporis brunneis, ellipsoideis, 7–8 × 5–5.5 μ; odore farinaceo.

Sub foliis in pinetis, St. Washington, Am. bor.

Fructifications small, 2–10 mm. in diam., globose to irregularly lobed, soft, spongy, surface smooth, white with ochraceous mottling, becoming snuff-brown; fibrils scanty above, rhizomorphic below; peridium simple, 200–400 μ thick, of coarse hyaline hyphae, the outer part oxidized darker; gleba white then brown (drying raw umber); cavities small, rounded, partly filled with spores (FIG. 14); septa 60–70 μ broad, including the hymenia, of large hyaline hyphae; basidia 4-spored, cylindrical, exceeding the paraphyses about 7 μ, 14–20 × 3–5 μ; spores brown, ellipsoid, 7–8 × 5.5 μ (FIG. 15); odor farinaceous.

In heavy duff, among mycorrhizal roots of hemlock. August. The habitat of *R. exiguus* is similar to that of *R. parasiticus*.

SPECIMENS EXAMINED:

Washington: Pierce County, Silver Springs Recreational Area, *S. M. Zeller, 8278, type,* Aug. 18, 1937; Yakima County, east side of Natches Pass, Mt. Rainier Forest Reserve, *D. E. Stuntz,* Aug. 20, 1937 (in Zeller Herb., *8279*).

2. RHIZOPOGON ROSEOLUS (Corda) Zeller & Dodge.

In the Herbarium of the Department of Plant Pathology, University of Wisconsin, there is a collection of this species under the name "*Rhizopogon roseus* Bresadola n. sp." This was collected by Dr. B. O. Dodge, "opposite Stand Rock, Kilburn, Dells of the Wisconsin, Aug. 1905 (Fide Bresadola)." The material is unmistakably *R. roseolus*. It perhaps will be necessary to disregard Bresadola's name in the synonyms for *R. roseolus,* since

another collection (*5914* in Lloyd Collections) under the same name is referable to **R. Vittadinii** (Tul.) Zeller, comb. nov. (*R. rubescens* var. *Vittadinii* Tul.).

Some have expressed the opinion that material referred to this species is merely a very mature stage of another species like *R. rubescens* because of the gelified condition of the vesiculose paraphyses (Coker & Couch, Gasteromycetes of East. U. S. *pl. 107, f. 12, 13*) and hyphae. A collection from Prof. James McMurphy taken at Governor's Camp, Big Basin, California (no. *302*), is very young and without spores but the paraphyses are heavily gelatinized.

Three collections by D. H. Linder and R. F. Smart from Richmond, Va., are quite typical.

3. **Rhizopogon separabilis** sp. nov.

Fructificationes subsphaericae, lobulatae, 1.5–4 cm. crassae, glabrae, albae vel "cartridge buff," cum maculis "vinaceous pink," dein "cream buff," siccatae fuscae; fibrillis paucis vel numerosis; peridio simplici, facile a glebo separabili, 425–550 μ, crasso, prosenchymato lento hyalino, siccato fragili; gleba alba, dein "buffy citrine" quando lecta, siccata "isabella color"; locellis parvulis, irregularibus; septis hyalinis, prosenchymatis cum hyphis laxis scissilibusque ad angulos, 15–26 μ, crassis inter hymenia; basidiis 4–6-sporis, cylindraceis, 8–11 $\times$ 3.5–5 μ; sterigmatibus 4–6 μ longis; sporis 2-guttulatis, inaequilateraliter ellipsoideis, singulatim hyalinis, 5–7 $\times$ 1.5–2.5 μ; odore grato farinaceo vel ei *Solani tuberosi* simili.

In terra arenosa sub *Pino contorta,* prope oceanum, Oregon, Amer. bor.

Fructifications subspherical, somewhat lobed, 1.5–4 cm. in diam.; surface rather smooth, traversed by few or many fibrils, white to cartridge buff with vinaceous pink spots, becoming "cream-buff," changing to russet where bruised, drying fuscous; peridium simple, easily breaking (shell-like) from the gleba when fresh, vinaceous tawny where cracked, 425–550 μ thick, of tough, hyaline, prosenchymatous strands plaited together, drying brittle after separation (FIG. 17); gleba white, then buffy citrine when fresh, drying isabella color; cavities rather small, irregular; septa hyaline, mostly prosenchymatous but sometimes of loose hyphae at the angles, then scissile there, 15–26 μ broad between hymenia; basidia 4–6-spored, cylindrical, 8–11 $\times$ 3.5–5 μ; sterigmata nearly as long as the spores; spores mostly 2-guttulate, with nucleus equatorially placed (as in spores of *R. roseolus*), ellipsoid, hyaline when alone, 5–7 $\times$ 1.5–2.5 μ (FIG. 18); odor pleasantly farinaceous or earthy, like potatoes.

In sand under *Pinus contorta* along coast, Florence to Waldport, Oregon. July and November.

The peridium as in *R. atlanticus* is easily separable and in mature specimens it is irregularly dehiscent, exposing the gleba (FIG. 11). The peridium is tough, becoming shell-like when dry. It differs from *R. atlanticus* in the structure of the peridium and trama, and size of spores.

SPECIMENS EXAMINED:

Oregon: Lane County, Florence, *A. H. Smith, A. B. Hatch,* and *S. M. Zeller,* Nov. 22, 1935, type, Zeller no. *8236.* Sutton Lake, *Dr.* and *Mrs. D. P. Rogers* no. *415, 451,* Nov. 26, 1937; Lincoln County, Waldport, S. M. Zeller, *8176,* July 3, 1936.

4. **Rhizopogon Thaxteri** sp. nov.

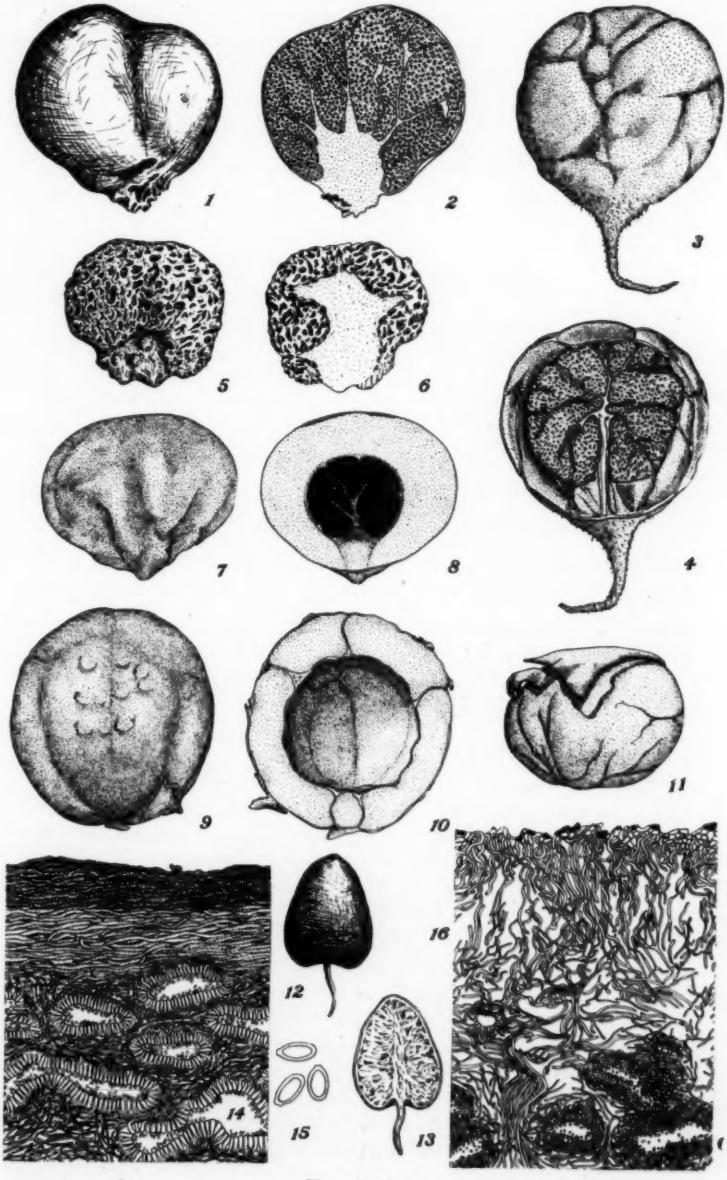
Fructificationes subglobosae, 1 cm. latae, sordide albidae tactu rubescentes, dein "carob brown" vel "chestnut brown"; fibrillis paucis, liberis sed ad superficiem inferiorem stupposim applanatis; peridio 600–700 μ crasso lento simplici, hyphis hyalinis vel flavidis magnis circa 5–6 μ crassis composito; gleba sordide olivacea, quando lecta, fusca conservata; locellis subglobosis, vacuis; septis 60–70 μ crassis, scissilibus, hyphis hyalinis contextis; basidiis cylindraceis, circa 18 $\times$ 4 μ; sporis subsessilibus, cylindraceis, supra rotundatis, infra cicatricula sterigmatica ornatis, subhyalinis, 6–8 $\times$ 1.5–2 μ.

Sub *Pino Strobo,* prope Kittery, Maine, Am. bor. (*R. Thaxter*).

Fructifications subglobose, 1 cm. in diameter, dirty-white, staining reddish when fresh, becoming carob-brown to chestnut-brown; fibrils scanty, free but flattened against the lower side, giving a general felty appearance to the surface; peridium 600–700 μ thick, tough, of one layer of large, thin-walled, hyaline or yellowish hyphae about 5–6 μ in diam. (FIG. 28); gleba dirty-olive when fresh, dark-brown in preservative; cavities subglobose to irregular, empty; septa 60–70 μ (30–35 μ between the hymenia), of loosely woven hyphae, scissile, hyaline; basidia cylindrical, about 18 $\times$ 4 μ; spores almost sessile, cylindrical with rounded distal end and sterigmatic scar at base, subhyaline, 6–8 $\times$ 1.5–2 μ (FIG. 29).

Under *Pinus Strobus,* Riley Place, Kittery, Maine, *R. Thaxter (1902 y),* type (in Farlow Herb. Harvard Univ., Thaxter Bequest, no. *6384*).

The spores in this species have the nucleus equatorially placed, appearing somewhat like a septum, as in *R. roseolus,* but the spores are much narrower and sessile or almost so. It is related to



FIGS. 1–16.

Rhizopogon Vittadinii (Tul.) Zeller, but the peridium is thicker, is composed of much larger hyphae, has a distinct red pigment in the oxidized outer layers of the peridium, and also differs in the spore characters mentioned above.

TRUNCOCOLUMELLA gen. nov.

Fructificationes depresso-sphaeroidae vel reniformes, basi rhizomorphicos, sterili instructae; columella truncoidea vel dendroidea et prominens; peridium persistens, indehiscens vel non separabile vel evanidum; gleba brunnea; sporis levis, ellipsoideis, coloratis, singulatim hyalinis (ut in *Rhizopogonis*).

Fructifications depressed-spheroid to reniform, from a rhizomorphic base; *columella* stump-like to dendroid, prominent; *peridium* persistent, indehiscent, not separating from the gleba, but sometimes early evanescent; gleba brown; spores smooth ellipsoid, colored but almost hyaline when alone (as in *Rhizopogon*).

This genus has spores and glebal structure like those of *Rhizopogon* but the stout, branched columella is the distinguishing character to separate it from that genus (FIG. 2, 6). It has some relationship therefore with *Dendrogaster* and *Hysterangium* but does not have the gelatinous-cartilaginous glebal tissues as in the latter.

The type species is:

5. **Truncocolumella citrina** sp. nov.

Fructificationes depresso-globosae vel reniformes vel cordatae, 2.5–4 cm. crass., 1.6–4 cm. alt.; superficie deorsum laevi, superne leniter rimoso-areolata, citrina, inquinate cremea vel "old gold" siccata; columella truncoidea vel dendroidea, supra lamellis alboluteis prominentibus composita, hyphis 4–7 μ crass., byssoideis contexta, basi rhizomorphico citrina instructa; peridio 70–100 μ crass., hyalino, ad superficiem; hyphis citrinis radialibus tecta, gleba "honey yellow," "tawny-olive" siccata; septis 50–60 μ crass., hyphis magnis laxe implexis; basidiis cylindraceis bi-vel tetrasporis 17–20 $\times$ 4–5 μ, sterigmatibus brevibus; sporis ellipsoideis, uniguttulatis, leniter brunneolis, sub lente subhyalinis 6–10 $\times$ 3.5–5 μ; odore grato.

Fructifications depressed-globose to reniform or cordate, 2.5–4 cm. broad, 1.6–4 cm. high; surface glossy smooth below, dull and sometimes cracked-areolate above, whitish then citrine yellow, drying sordid cream color to old gold where bruised; columella stump-like or dendroid, the base and branches of yellowish-white tissue, composed of large, loose-meshed hyphae, 4–7 μ in diam.; sterile base merely the broad base of the columella, citrine yellow,

usually from a large yellow rhizomorph; peridium 70–100 μ thick, of interwoven hyphae which are citrine-colored near the surface and hyaline below, in young specimens the superficial hyphae are most often radial (FIG. 16); gleba honey-yellow drying tawny-olive; septa 50–60 μ between hymenia, of loose, large, almost parallel hyphae; basidia cylindrical, 2–4-spored, 17–20 $\times$ 4–5 μ; sterigmata about ½ the length of the spores; spores ellipsoid, 1-guttulate, brownish in mass, almost hyaline under the scope, 6–10 $\times$ 3.5–5 μ (FIG. 23); odor pleasant.

Under forest duff or emergent, under conifers. Clackamas, Douglas, and Linn Counties, Oregon, King County and Mt. Rainier National Park, Washington, and Humboldt County, California. August to November.

This species has proven to be one of the most common of the hypogeous fungi in coniferous forests of the Pacific Northwest. The type collection includes 23 fructifications and another large collection comes from D. E. Stuntz, Seattle. Very mature specimens deliquesce in a manner similar to *Rhizopogon*.

SPECIMENS EXAMINED:

Washington: King County, Seattle, *D. E. Stuntz,* Oct. 18, 1937; Pierce County, Frying Pan Creek, Mt. Rainier National Park, *D. E. Stuntz,* Aug. 20, 1937.

Oregon: Clackamas County, about 100 yards up Paradise Park Trail from Twin Bridges Forest Camp, *S. M. Zeller, 8229,* Sept. 3, 1935; Douglas County, Comstock, *S. M. Zeller, 8320,* type, Oct. 20, 1937, *8401,* Oct. 23, 1937, and *H. M. Gilkey, A. M.* and *D. P. Rogers,* and *S. M. Zeller, 8363, 8387, 8389,* Nov. 6, 1937; Linn County, 5 miles S.E. of Lebanon, *G. S. Burlingham,* Nov. 5, 1934 (in Zeller Herb., *8213*).

California: Humboldt County, Spruce Cove, Trinidad, *H. E. Parks, 4120,* Nov. 20, 1932, *4623,* Nov. 1933, and *4624,* Sept. 1933 (in Parks Herb. and Zeller Herb.).

6. **Truncocolumella rubra** sp. nov.

Fructificationes piriformes, 2–3.5 cm. crassae, 2.5–3 cm. altae; peridio tenui, mox fere omnino evanido, hyphis infra hyalinis ext. rubidis; gleba sordide luteola, tactu in colore livido mutabili, siccitate umbrina, superficie nuda badia vel rubro-brunnea, solo tecta "aniline yellow"; locellis magnis labyrinthiformibus; columella 7–12 mm. crassa, subpercurrenti, cum ramis

tenuibus a latere apiceque radiantibus, a basi sterili non distincta, intus flavido-alba, tactu in colore livido mutabili, siccitate sordide flavida; septis circa 100 μ crassis, hyphis hyalinis implexis; basidiis 4-sporis, cylindraceis, 11–13 × 5–6 μ; sporis oblongo-ellipsoideis, ochraceo-brunneis, 10–12.5 × 4.5–5.5 μ.

Fructifications broadly pyriform, 2–3.5 cm. broad, 2.5–3 cm. high; peridium thin, almost entirely evanescent at maturity, composed of parallel hyphae, hyaline within, reddish on surface; gleba sordid light-yellow, changing bluish on bruising or exposure, drying raw umber; surface exposed by the early dehiscence of the peridium (FIG. 5), bay to brighter reddish-brown above, aniline-yellow where covered by soil; cavities relatively large, labyrinthiform (FIG. 21); columella stout, 7–12 mm. broad, almost percurrent, with narrow branches radiating laterally and terminally (FIG. 6), extended below as a sterile base, yellowish-white within, changing bluish when bruised or exposed, drying sordid yellowish; septa about 100 μ thick, composed of hyaline, intertwined hyphae; basidia 4-spored, cylindrical, 11–13 × 5–6 μ; spores oblong-ellipsoid, ochraceous-brown, 10–12.5 × 4.5–5.5 μ (FIG. 22).

Emergent from heavy duff under hemlock, near Snoqualmie Pass, King County, Washington, *D. E. Stuntz*, Aug. 19, 1937, type (in Zeller Herb. *8272*).

This Gasteromycete reminds one of an early stage of *Boletus* in peridial color, change of tissues to blue when cut or bruised, and in shape of spores. The gleba, however, does not separate from the columella (stipe) below and the hymenium lines chambers rather than tubes. In spore shape and presence of columella only is it similar to the brown or ochre-spored species of *Hysterangium*.

7. **Melanogaster euryspermus** (Zeller & Dodge) comb. nov.

Syn. *Melanogaster ambiguus* var. *euryspermus* Zeller & Dodge, Ann. Mo. Bot. Gard. **22**: 373. 1935.

Further study of fresh material of this fungus shows it to differ in so many points from *M. ambiguus* that the variety is raised to specific rank. The olivaceous color and spongy surface of *M. ambiguus* are in striking contrast to the warm, brown, smooth and firm surface of *M. euryspermus*. The two also differ in structure of peridium, and color, walls, and shape of spores (FIG. 40, 45). In additional material the size of spores in *M. euryspermus* is found to range up to 18 μ long and 11 μ broad.

8. **Melanogaster luteus** nom. nov.

Syn. *Melanogaster microsporus* Mattirolo, Beitr. Krypt.-Fl. Schweiz 8^2: 37–29. 1935.—Not *Melanogaster microsporus* Velenovsky, Ceske Houby 809. 1922.

Fructifications subglobose to reniform, 2–3 cm. in diam., golden-yellow to mars-orange, drying buckthorn-brown or darker; peridium duplex, outer layer golden-yellow, 100–140 μ thick, of large loosely meshed hyphae with clamp connections, inner layer more compact, of parallel hyphae, underlaid by a parenchyma of the outer gleba; gleba brownish-black with yellowish-white septa; septa of hyaline gelatinized hyphae, 30–50 μ broad; basidia piriform, 5–8 $\times$ 4–6 μ, hyaline, 4–8-spored (mostly 8); spores dark-brown, ellipsoid, minute, 3–4.3 $\times$ 2–2.3 μ (FIG. 37); odor mildly of garlic.

Hypogeous, under maple, chestnut, and pine. Como Province, Italy, and Linn County, Oregon.

This species is preferred by pine squirrels, the spawn where the Oregon collection was taken having previously been raided by these rodents.

SPECIMENS EXAMINED:

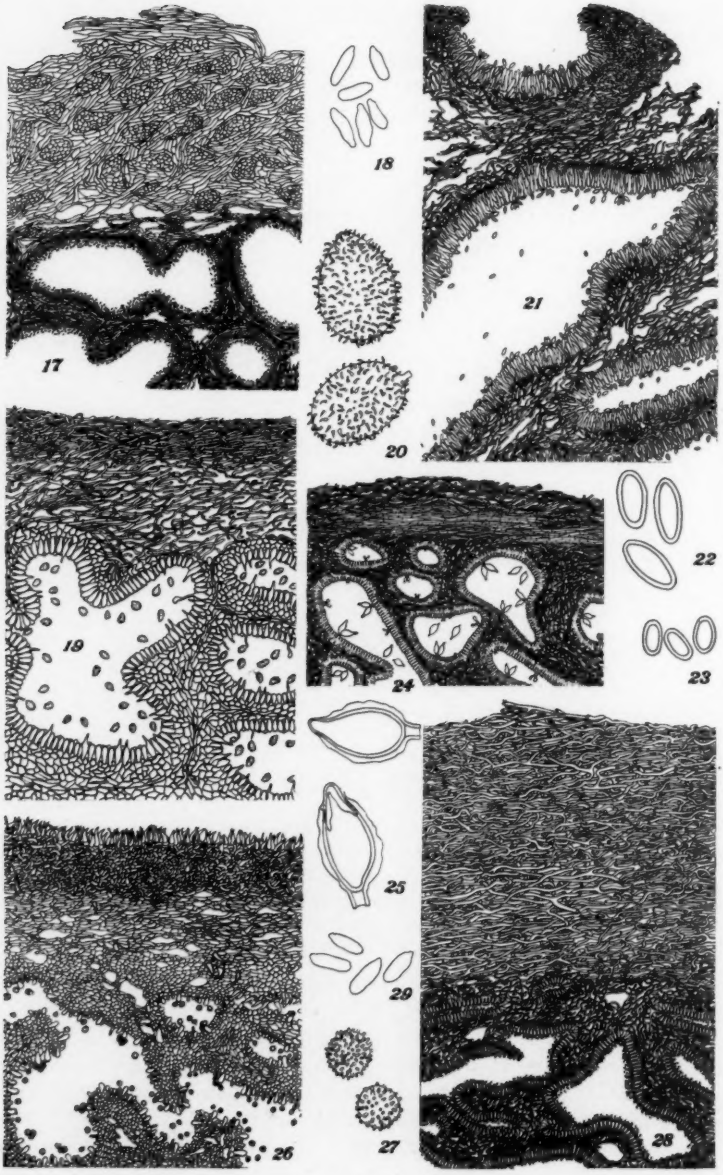
Italy: Como Province, Rodero, *O. Mattirolo,* type of *M. microsporus* Mattirolo (portion in Zeller Herb.).

Oregon: Linn County, Trout Creek Recreation Area, Sept. 23, 1937, *S. M. Zeller, 8312.*

9. **Melanogaster macrocarpus** sp. nov.

Fructificationes "snuff-brown" vel "tawny-olive," siccatae obscuriores, 6–12 cm. crassae; peridio circa 100–140 μ crasso, prosenchymato, cellulis crasso-tunicatis, circa 7 μ diam., composito, peridium tramale gelatinosum interruptum investiente; gleba atrata; septis albis gelatinosis; basidiis hyalinis, crassoclavatis, 4-sporis, sterigmatibus circa 3 μ longis; sporis lato-obovoideis, 12–15 $\times$ 8–11 μ, fuscis.

Fructifications large, up to 12 $\times$ 8 $\times$ 6 cm., snuff-brown or tawny-olive, drying russet to mars-brown and darker; peridium about 100–140 μ thick, of a compact prosenchyma which is dark-brown at the surface shading to lighter within, its cells thick-walled, about 7 μ in diam., overlying a gelatinous tramal peridium about 50–100 μ thick, which is interrupted by prosenchymatous plates (septa) which have unbroken connection with the peridium



FIGS. 17–29.

and extend into the gleba (FIG. 30); gleba black, mottled by white septa which are about 30–60 μ thick, of gelatinous hyphae and a central plate of prosenchyma; basidia hyaline, broadly clavate, 4-spored, sterigmata $\frac{1}{5}$ the length of the spores; spores broadly obovoid, 12–15 $\times$ 8–11 μ, dark-brown (FIG. 31); odor of spoiled silage or of onions without the tear-producing qualities.

In forest duff under conifers, especially *Tsuga*, August to October. Clackamas and Lane Counties, Oregon.

Oregon: Clackamas County; on trail to Paradise Park from Twin Bridges Forest Camp, *S. M. Zeller, 7759, 8015, 8230,* type, *Dr.* and *Mrs. D. P. Rogers* (Zeller, *8262*); Lane County, Belknap Springs, *S. M. Zeller* & *G. R. Hoerner* (Zeller, *8241*).

This species is doubtless near *M. microsporus* Vel., type of which is not available.

10. MELANOGASTER PARKSII Zeller & Dodge.

Since the preparation of the manuscript dealing with *Melanogaster* (Ann. Mo. Bot. Gard. **23**: 639–655. 1936) the writer has had opportunity to study two collections taken from California by H. W. Harkness, and which because of their historical value should have been cited as *M. Parksii.* These were his numbers *68* and *128* referred, by him respectively, to *M. aureus* Tul. and *M. sarcomelas* Tul., reported as from Alameda, Marin, and Placer Counties, California. (Cal. Acad. Sci. Proc. III **1**: 260–261. 1899.)

11. DENDROGASTER CONNECTENS Bucholtz.

The type material of this species in the Farlow Herbarium at Harvard University has become a mixture of two species of *Dendrogaster.* The material is preserved in 3 vials labelled by F. Bucholtz and all bearing the same collection number (no. *284*) but unfortunately each vial bears a different collection date. Doubtless no. *284* was the type collection taken Aug. 14, 1899, and since the two other vials bear two subsequent dates (Aug. 25, 26, 1907, and July 30, 1916) in his handwriting, evidently Bucholtz assumed the two subsequent collections to be *Dendrogaster connectens* and assigned them the same number (no. *284*). The material of the second species in the mixture, therefore, was

probably introduced unwittingly through one or both of the subsequent collections.

There are in all approximately 10 very small fructifications which have been cut into two or more pieces. The writer has examined practically all of these, however, and segregated them into separate vials. There are about 4 fructifications of *D. connectens* all of which are quite young although they contain a few spores which are apparently mature. Fortunately there is such extreme difference between the spores of the two species that they were readily segregated. In all of the material there are so many unattached spores that *attached spores* only furnished the one definite criterion for segregating the two types.

The size of the spores of *D. connectens* is slightly variable, 14–21 × 10.6–12.4 μ without the utricle, up to 14 or 15 μ broad including the utricle. The peridium is 70–100 μ thick.

For the other species, type material of which was mixed with that of *D. connectens*, the writer is proposing the name:

12. **Dendrogaster olivaceus** sp. nov.

Fructificationes subglobosae, deorsum costatae, usque ad 1.5 cm. crassae, superficie hebeti, laevi, siccitate maculosae pallido et fusco-brunneae; peridio 75–200 μ crasso, hyalino, prosenchymatico superficie fuscato, hyphis compacte implicatis composito; columella simplici vel ramosa, saepe percurrenti, prosenchymatica; gleba fulva, locellis mannis; septis tenuibus; basidiis clavatis, 1–4-sporis, sterigmatibus brevibus; sporis immaturis laevibus, utriculo pellucido laxe rugoso textis, obovoideo-lanceolatis, apiculo pedicelloque prominentibus, 19.5–35.5 × 10.6–14.2 μ (e basidiis unisporis, 38–45 × 15–18 μ), luteobrunneis; sporis maturis fuscatis apiculo obtuso utriculoque rugoso.

Fructifications subglobose, costate below, up to 1.5 cm. in diameter; surface dull, even, white and overlaid by a white, thin weft of entangled mycelium, drying mottled light and dark-brown; peridium 75–200 μ thick, hyaline, prosenchymatous, surface darker, of closely woven hyphae (FIG. 24); columella simple or branched, sometimes percurrent, prosenchymatous; gleba of rather large cavities, separated by thin septa, light-grayish becoming tawny in old specimens; basidia clavate, 1–4-spored with very short sterigmata; spores smooth when young covered with a clear more or less closely applied utricle, obovoid-lanceolate with a cylindrical or capitate apiculus and prominent claw-like base, 19.5–35.5 × 10.6–14.2 μ (spores from 1-spored basidia larger, 38–45 × 15–18 μ), light yellowish-brown, mature spores smaller,

darker brown with rounded or broadly apiculate tips, and with a closely applied but wrinkled utricle which may rupture where the rounded tip protrudes (FIG. 25).

On the ground under leaves. Benton County, Oregon, Santa Cruz County, California, and Mikhailovskoe, near Moscow, U. S. S. R. (Russia).

As mentioned above, the type of this species was found mixed with the type of *D. connectens* in the Farlow Herbarium. It perhaps was collected on August 25, 26, 1907, or July 30, 1916. The spores are very similar to those of *Hymenogaster olivaceus*. (Ann. Mo. Bot. Gard. **21**: 689. 1934.)

A collection by H. E. Parks (no. *503*), taken in California, is identical with the type of *D. olivaceus*. This collection was previously referred to *Hymenogaster olivaceus* and other collections so referred may be thus incorrectly identified. Fresh material should always be sectioned vertically to observe at once any sterile tissues such as columella.

SPECIMENS EXAMINED:

U. S. S. R. (Russia): Moskva, Mikhailovskoe, *F. Bucholtz*, no. *284 in part*, type.

California: Santa Cruz County, Felton Big Trees, *H. E. Parks, 503*, Apr. 13, 1919 (in Zeller and Univ. of Calif. Herb.).

Oregon: Benton County, near Corvallis, *S. M. Zeller, 4606*, April 21, 1937.

13. **Hydnangium ellipsosporum** sp. nov.

Fructificationes subglobosae, circa 1–2 cm. altae, 1–1.3 cm. crassae, albae vel pallido-ochraceo-luteae, laeves; peridio 80–180 μ crasso, strato externo compacto facile separabilo, interno laxo, hyphis hyalinis vel pallido-luteis intertexto; gleba cremicolorata, ochraceo-lutescenti; locellis irregularibus, medio-magnitudinis; septis circa 80–90 μ crassis (hymeniis annumeratis), parenchymatibus; basidiis 1–2-sporis, clavatis, 25–31 × 11–17 μ, sterigmatibus 7–9 μ longi; sporis lato-ellipsoideis, ochraceis, echinulatis, 16.5–21(23) × 12–15(16) μ.

Fructifications subglobose, usually taller than broad, about 1–2 cm. tall, 1–1.3 cm. broad, white to pale ochraceous-buff, smooth; peridium 80–180 μ thick, the outer part of very compact intertwining hyphae (FIG. 19), the inner part of very open meshed hyphae, allowing the outer peridium to be easily separable; gleba cream-color, becoming ochraceous-buff; cavities medium size;

septa about 80–90 μ thick including the 2 hymenia with parenchyma between, often scissile at the angles where an open meshwork of hyphae occurs; basidia 1–2-spored (mostly 1), clavate 25–31 $\times$ 11–17 μ; sterigmata 7–9 μ long; spores broadly-ellipsoid, ochraceous, echinulate, 16.5–21(23) $\times$ 12–15(16) μ (FIG. 20).

Under conifers, Benton and Clackamas Counties, Oregon. June to August.

This species is very distinct because of the very large ellipsoid spores (FIG. 20). Rather large white rhizomorphic strands adhere to the surface of the peridium of some specimens but this character was not general enough to incorporate in the diagnostic description.

SPECIMENS EXAMINED:

Oregon: Benton County, Alsea Mountain, June, 1937, *Dr.* and *Mrs. D. P. Rogers, 463,* type (in Rogers Herb. and Zeller Herb., *8457*); Clackamas County, Twin Bridges Forest Camp, Aug. 9, 1937, *D. P. Rogers* (in Zeller Herb., *8254*).

14. HYDNANGIUM LAEVE (Hesse) Zeller & Dodge.

In our publication on *Arcangeliella*[2] the collection by R. Thaxter (*B2H*) taken at Cranberry, N. C., was incorrectly referred to *A. asterosperma.* There is one whole fructification in the collection. It has no sterile base nor lactiferous ducts in the sterile tissues. Thaxter's collection *B2, H*[1], from Burbank, Tennessee, similarly referred, also lacks the characteristics of *Arcangeliella.* Even in tiny specimens, 2 mm. in diameter, which usually show sterile tissues at their best, there are no sterile base nor lactiferous ducts. Both of these collections are *Hydnangium laeve.*

15. **Hydnangium setigerum** sp. nov.

Fructificationes 0.5–1.5 cm. crassae, subglobosae, rhizomorphi tenuibus affixis; superficie villosula alba vel brunneola; peridio 170–200 μ crasso, strato externo hyphis hyalinis intertexto, superficie setigerosa, strato interno prosenchymato hyalino, lacunosibus; gleba cremeo-alba brunneolescenti; locellis irregularis; septis circa 50–60 μ crassis parenchymati hyalini; cystidiis laevibus tenuatis, moniliformibus; basidiis magnis, lato-clavatis, 1-, 2-, vel 4-sporis, sterigmatibus 5–6 μ long.; sporis sphaericis, brunneolis, echinulatis, 6–7 μ diam.

[2] Ann. Mo. Bot. Gard. **33**: 631–634. 1936.

Fructifications 0.5–1.5 cm. in diameter, subglobose, attached by a single slender rhizomorph; surface delicately plush-like under a hand lens, white to light-brown; no sterile base nor columella; peridium 170–200 μ thick, of a meshy network of hyaline prosenchyma below a layer of interwoven hyhae with a superficial palisade of light-brown, thick-walled, sharp or capitate, lanceolate setae, 18–34 μ long, in places such setae also arising from various depths in the peridium and sometimes extending from the inside of the peridium into the outer glebal chambers (FIG. 26); gleba creamy-white, changing light-brown; cavities small, irregular; septa 50–60 μ broad, of hyaline parenchyma; cystidia tapered, smooth or moniliform; basidia large, broadly clavate, 1-, 2-, or 4-spored; sterigmata 5–6 μ long; spores spherical, light brown, with short, blunt, echinulae, 6–7 μ in diam. (FIG. 27), (giant spores from 1-spored basidia 9–10 μ and with more prominent echinulae).

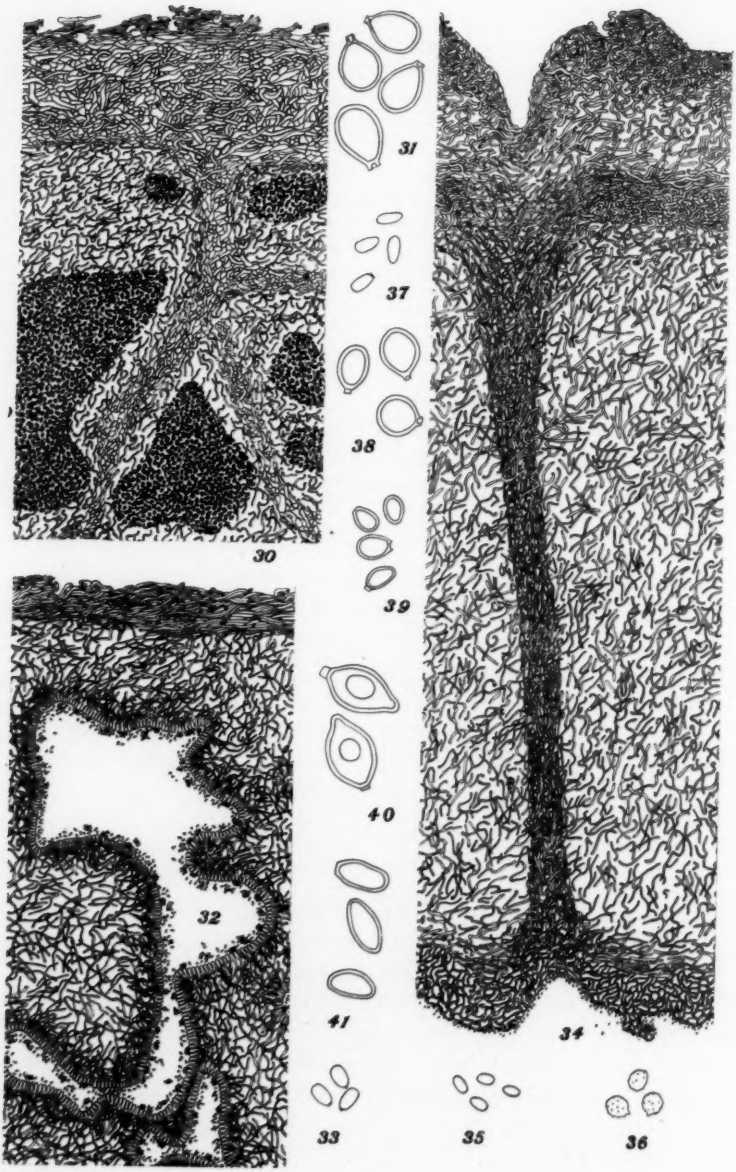
Under moss in dense coniferous woods, Roaring River Fish Hatchery, Linn County, Oregon, Mar. 20, 1934, *S. M. Zeller, 8202,* type; Benton County, Oregon, Alsea Mt., *Dr.* and *Mrs. D. P. Rogers,* Oct. 3, 1937.

Hydnangium setigerum is a most distinctive species. The setae of the peridium occurring at various levels and in places arising from and extending inward from the inside of the peridium are difficult to explain (FIG. 26). They do not stain particularly dark in KOH as in many of the species of *Hymenochaete.* Again, the moniliform cystidia, similar to those of certain species of *Aleurodiscus,* are prominent and characteristic. *Arcangeliella pilosa* has erect hairs on the surface of the peridium but they are not thick-walled as the setae in *H. setigerum.*

16. ELASMOMYCES RUSSULOIDES Setchell.

In a recent publication on the genus *Arcangeliella*[3] this species was referred to synonymy with *A. alveolata* (Cooke & Massee) Zeller & Dodge. Since then Dr. Setchell has kindly sent a portion of the type of *E. russuloides.* It was collected by Dr. Setchell, April 29, 1905, and is a good species of *Elasmomyces.* The material I had previously studied and which was erroneously labeled as *type* was collected by Dr. N. L. Gardner, Nov. 24, 1904. The latter is *A. alveolata,* has lactiferous ducts and columella, but lacks

[3] Zeller, S. M. & Dodge, C. W. *Elasmomyces, Arcangeliella,* and *Macowanites.* Ann. Mo. Bot. Gard. **23**: 620. 1936.



FIGS. 30–41.

the definite stipe and the reddish peridium which is so evident in dried material of *E. russuloides*. There is a similarity in the markings of the spores of *Arcangeliella alveolata*, *A. Gardneri*, and *Elasmomyces russuloides*, but those of *A. Gardneri* are somewhat ellipsoid while the spores of the other two species are spherical.

17. GASTROSPORIUM SIMPLEX Mattirolo.

The writer has had opportunity to study type material of this species from the Farlow Herbarium, Harvard University. It would appear that Mattirolo [4] and Pilat [5] have both overlooked the roughness of the spores (FIG. 36). Under oil immersion and also with dark field illumination the verrucosity shows plainly. The genus description therefore should be emended to include verrucose spores.

Because of the type of development one may agree with Pilat that *Gastrosporium* be placed in a family by itself. Since the work of Pilat indicates the development of the fructifications of *Gastrosporium* to be the converse of that described by Fitzpatrick [6] for *Phallogaster*, the writer would place the family, Gastrosporiaceae Pilat, in another series of development parallel with that of the Hysterangiaceae, but doubtless outside the Hysterangiales.

18. **Hysterangium Darkeri** sp. nov.

Fructificationes 1–4 cm. crass., depresso-globosae, lobulatae, "deep grayish olive" pellucidae, inquinatae, "pale olive buff" vel "avellaneous" siccatae; superficie glabra; superne funiculi fere desunt, inferne inconspicui; columella percurrens ramosaque, lamellis radiantibus ex fructificationis axe ortis, hyphis gelatinosis hyalinis compositis; peridio tenui evanescenti, 35–100 μ crass., hyphis tenuibus composito, super peridium tramiatem formato; gleba gelatinosa, "dark-ivy-green," "slate-olive" siccata, in strato crasso externo novissimis glebae partibus cum insulis parenchymaticis evolventibus; septis 80–125 μ crass., hyphis laxis, septatis, parallelibus, gelatinosis composita; basidiis irregulariter cylindraceis 4-vel 8-sporis, 17–22 × 3–7 μ; sporis lato-ellipsoideis, sessilibus, "olive-green," singulatim hyalinis, 4–5 × 2–2.5 μ.

[4] Mattirolo, O. Memorie della Reale Accademie delle Scienze di Torino (Ser. II) **53**: 361. 1903.

[5] Pilat, A. Bull. Soc. Myc. Fr. **50**: 37–49. *illus.* 1934.

[6] Fitzpatrick, H. M. A comparative study of the development of the fruit body in *Phallogaster*, *Hysterangium*, and *Gautieria*. Ann. Myc. **11**: 119–149. *illus.* 1913.

Fructifications 1–4 cm. in diameter, depressed globose, somewhat lobed; a translucent deep-grayish-olive, drying a dirty-pale-olive-buff to avellaneous, surface glabrous, a few fibrils below, almost wanting above; columella percurrent and with whitish cartilaginous lamellae radiating from the middle of the fructification; peridium thin, evanescent, 35–100 μ thick, of slender thin-walled hyaline hyphae, underlaid by a thick tramal peridium (FIG. 32); gleba gelatinous, dark-ivy-green drying slate-olive the newest parts of the gleba together with parenchymatous islands evolving in a thick external layer (tramal peridium?); septa 80–125 μ broad, of gelatinous loose septate hyphae about 3–4 μ in diam. bordered on each side by finer sub-hymenial hyphae which are closely entwined; basidia irregularly cylindrical, 4–8-spored (mostly 6), 17–22 $\times$ 3–7 μ; spores sessile, broadly ellipsoid, hyaline under the scope, olive-green *en masse*, 4–5 $\times$ 2–2.5 μ (FIG. 33).

On ground in coniferous woods. Utah and California. Summer.

H. Darkeri is similar to *H. Phillipsii* in spore size and development of the gleba just beneath the peridium. It differs, however, in color, thickness, and structure of the peridium, size of basidia, number of spores per basidium and the fact that the spores are sessile. In *H. Phillipsii* the peridium is composed of a thin-walled pseudoparenchyma. It may be significant that the basidia in *H. Darkeri* are typical of those found in phalloids. The size of the spores is also of the same magnitude as those found in *H. Phillipsii, Phallobata, Phallogaster,* etc.

SPECIMENS EXAMINED:

Utah: Salt Lake County, East of Brighton (Silver Lake), elev. 9600 feet, *G. D. Darker, 5957,* type, Aug. 3, 1936 (in Farlow Herb., Harvard, and a portion in Zeller Herb.).

California: Siskiyou County, Mt. Shasta, 8000 feet, *W. B. Cooke, 8580,* July 14, 1937.

19. **Hysterangium affine M. & R. oreades** var. nov.

This variety is distinguished from the species by the softer texture of the gleba and its association with a conifer, under or near which it forms "fairy rings."

The basidia are 4–6-spored; spores 10–14.5 $\times$ 4–5.3 μ, fusoid-

ellipsoid; gleba drying deep-grayish-olive to dark-ivy-green (soaked up slate-olive to deep-slate-olive).

Under or near *Abies lasiocarpa,* forming " fairy rings " 10 to 35 feet in diameter. Utah. Elevation 8750–9000 feet.

Some of the fructifications project slightly above the surface of the ground. Dr. Darker's collection notes include the statement that " their presence was otherwise indicated by little pit-like areas where mature fruiting bodies had decayed or by the raised bump where the mature fruiting bodies had pushed up the earth. . . . The best development of fruiting bodies was in gravelly soil. The specimens were attached to one another in clumps or were separate, the larger groups bulging the surface of the soil and thus evident before breaking through."

SPECIMENS EXAMINED:

Utah: Salt Lake County, Brighton (Silver Lake), *G. D. Darker, 5873,* type, July 30, and *5945,* Aug. 3, 1936.

20. HYSTERANGIUM PHILLIPSII Harkness.

It was necessary to restudy the material of *H. Phillipsii* to make sure its distinction from *H. Darkeri.* Specimens sent from Ohio by W. R. Lowater were given especial consideration. When soaked in water these nearly regained their original stature, and proved to be *Phallogaster saccatus* Morgan, which has spores the same magnitude as those of *H. Phillipsii* but other structures distinct. Thus, it appears that so far as known *H. Phillipsii* is a Pacific Coast species.

21. HYSTERANGIUM STOLONIFERUM var. AMERICANUM Fitzpatrick.

Since the publication of *Hysterangium,*[7] where *H. stoloniferum* var. *americanum* Fitzpatrick was considered as synonymous with *H. clathroides* Vitt., the writer has had opportunity to examine fresh material from Oregon and California which undoubtedly is the same as that described by Fitzpatrick. Two collections (nos. *269* and *299*) from Prof. James McMurphy taken by him near Stanford University answer this description and seem to be

[7] Ann. Mo. Bot. Gard. **16**: 83–128. *illus.* 1929.

identical with that described by Fisher [8] from California. Fruiting bodies taken by myself from Comstock, Oregon, January 12, 1938, were produced on large cord-like stolons up to 15 cm. long which in turn were branches from similar large white rhizomorphs which extended for several feet under the forest duff. The general habit of this fungus in the forest duff is entirely distinct from *H. clathroides* and *H. clathroides* var. *crassum,* as described by us, both of which I have collected in quantity. Fischer seems entirely justified in retaining Fitzpatrick's variety name.

22. PHALLOBATA ALBIDA Cunningham.

This odd genus and species was collected in Linn County, Oregon, in March. It was growing on decayed wood (humus) under maple, hazel, and Douglas fir. It has characters reminding one of *Hysterangium Phillipsii* on the one hand and *Phallogaster saccatus* on the other. The queer lobes surmounting the gleba proper are reminiscent of *Phallogaster* or *Hysterangium* gone wrong, or perhaps more properly a degenerate from the Phallales. It is the writer's opinion that this genus, together with *Phallogaster,* should be referred to the Hysterangiaceae, as Fischer has done.

GELOPELLACEAE fam. nov.

Fructificationes subglobosae; peridio tenui, stratum crassum continuum gelatinosum investiente; gleba colorata, locellis columellaque praedita, locellis hymeniis circumdatis; sporis levibus, parvis, coloratis.

Fructifications subglobose; peridium thin, surrounding a thick, continuous, gelatinous layer; gleba colored, with locules and a columella; walls of locules lined with a basidial hymenium; spores smooth, small, colored.

The type genus is *Gelopellis.*

Gelopellis gen. nov.

Fructificationes hypogeae, subglobosae; perido tenui, stratum, crassum, gelatinosum, continuum investiente; columella simplici vel dendroidea, gelatinosa; gleba fusca vel obscure olivacea locellis parvis praedita; hymenio laevi, e basidiis paraphysisque composito; sporis parvis, ellipsoideis, levibus, brunneis.

[8] Fischer, Ed. Hypogaeen-Studien. I. Zur Kenntnis der Gattung *Hysterangium.* Ber. Schweiz. Bot. Ges. **48**: 29–44. *illus.* 1938.

Fructifications hypogeous, subglobose; peridium thin, surrounding a thick hyaline, gelatinous, continuous layer (FIG. 8) which entirely envelopes the fertile portion of the gleba, which is very dark-brown or deep-olivaceous; columella simple or branched, gelatinous; hymenium of basidia and paraphyses covering the walls of small cavities; spores small, ellipsoid, smooth, brown.

The type species is *Gelopellis macrospora.*

This South American genus is a representative of a line of development between the Hysterangiaceae and the Phallaceae. The thick gelatinous layer immediately under the peridium is not interrupted by sterile or fertile cavities such as those in the tramal peridium of *Hysterangium* nor by sterile plates (sutures) of cortical or fundamental tissue as found in the genera representing the Protophallaceae and the egg stages of those representing the Clathraceae. This uninterrupted gelatinous layer (tramal peridium) is similar to the gelatinous sheaths of egg stages in genera of the Phallaceae. This type of development, it would seem, marks another line from forms near the Hysterangiaceae but with undiscovered intervening links. For the present we are placing it in a new family, Gelopellaceae, by itself. This family is in the Hysterangiales just below the Phallaceae of the Phallales.

23. **Gelopellis macrospora** sp. nov.

Fructificationes 7–17 mm. crassae, subglobosae appendici radiciformi adfixae; peridio 180–320 μ crasso, lento, prosenchymato, super stratum hyalinum, gelatinosum, 2–4 mm. crassum; columella sparse dendroidea, basi conicio gelatinoso glebam fere percurrente; gleba atrobrunnea; locellis sphaericis vel elongatis, circa 35–50 μ crassis; septis circa 35–45 μ crassis (hymenio annumerato), hyphis hyalinis 3–4 μ crassis parallelis vel reticulato-intertextis compositis; paraphysibus valde gelatinosis; basidiis 4-sporis, cylindraceis, 3–4 × 12–18 μ; sporis ellipsoideis, 7–14 × 3.5–5 μ, obscure brunneis, levibus.

Fructifications 7–17 mm. in diam., subglobose, attached by a basal rhizomorphic cord; peridium 180–320 μ thick, of a tough meshy prosenchyma, covering a hyaline gelatinous layer 2–4 mm. thick, composed of fine somewhat vesiculose hyphae embedded in a translucent, colorless gel (FIG. 52); columella simple or somewhat branched, with a conic gelatinous base, extending as a narrow line to the summit of the gleba, of the same texture as the peridium (FIG. 8); gleba blackish-brown; cavities spherical to elongate, about 35–50 μ broad; septa about 35–45 μ broad (including hy-

menia), of parallel to reticulately meshed hyaline hyphae, 3–4 μ in diam.; hymenium of highly gelatinized paraphyses and slender basidia; basidia 4-spored, cylindrical, 3–4 $\times$ 12–18 μ; spores ellipsoid, 7–14 $\times$ 3.5–5 μ, dark-brown, smooth (FIG. 53).

The very fine hyphae of the subperidial gelatinous layer (tramal peridium) are somewhat vesiculose but do not show the peculiarly nodose clamp-connections found in those of *G. Thaxteri.* The spores of *G. macrospora* have 10–15 times the volume of those of *G. Thaxteri* (FIG. 54).

SPECIMENS EXAMINED:

Chile: Concepcion, *R. Thaxter,* Hypog. No. 1, type (in Thaxter Bequest to Farlow Herbarium).

24. **Gelopellis Thaxteri** (Zeller & Dodge) Zeller comb. nov.

Syn. *Hysterangium Thaxteri* Zeller & Dodge, Ann. Mo. Bot. Gard. **16**: 114–115. 1929.

KEY TO THE SPECIES OF GELOPELLIS

1. Peridium of interwoven hyphae; spores 3–4 μ long.....*G. Thaxteri.*
2. Peridium a meshy prosenchyma; spores 7–14 μ long.....*G. macrospora.*

PROTOPHALLACEAE fam. nov.

Fructificationes subglobosae, hypogeae vel epigenae; peridio plerumque tenui, e textu primario composito, peridium tramalem crassum gelatinosum laminis radiantibus interruptum investiente; gleba gelatinosa vel cartilaginosa, olivacea vel brunneola, a lamellis gelatinosis e basi vel columella radiantibus dissieta, cellulis ab initio cavis et tandem subfarctis, septis basidiophoris; sporis parvis, ellipsoideis, olivaceis vel brunneolis.

Fructifications subglobose, hypogeous or epigeous; peridium usually thin, of primary tissue, covering a thick gelatinous tramal peridium (volva) which is interrupted by radial membranes of primary tissue having unbroken connection with the peridium and gleba; gleba gelatinous or cartilaginous olivaceous or brownish, usually sectored by gelatinous plates radiating from the base or from a columella; cavities at first empty then almost filled with spores; basidial hymenium lining cavities; spores small ellipsoid, olivaceous or brownish.

25. PROTUBERA AFRICANA Lloyd.

Fructifications about 1.5–2 cm. in diameter, subglobose from a small rhizomorphic base, the surface smooth between reticula-

tions, brown; peridium a thin, tough layer (rind), composed of pseudoparenchyma about 14–20 μ thick, covering a white layer (tramal peridium) of loosely spaced thin hyphae imbedded in a gel, 2–3 mm. thick; columella branched from the base but the branches not visibly purcurrent, gelatinous; gleba olivaceous-brown, gelatinous (of the consistency and appearance of that of the greenish-spored species of *Hysterangium*) with a whitish enveloping membrane of fundamental tissue which has unbroken connection with the rind by occasional membranes (cortical plates) which extend through the intervening gelatinous tramal peridium, cavities small, almost filled with spores; septa of hyaline gelatinous hyphae; basidia phalloid, mostly 6–8-spored (4–8–); spores ellipsoid-ovoid, pip-shaped, or oblong, distinctly showing the sterigmatic scar, almost sessile, 5.5–6.3(8.5) $\times$ 2.5–3(3.5) μ.

In damp clay soil, Union of South Africa.

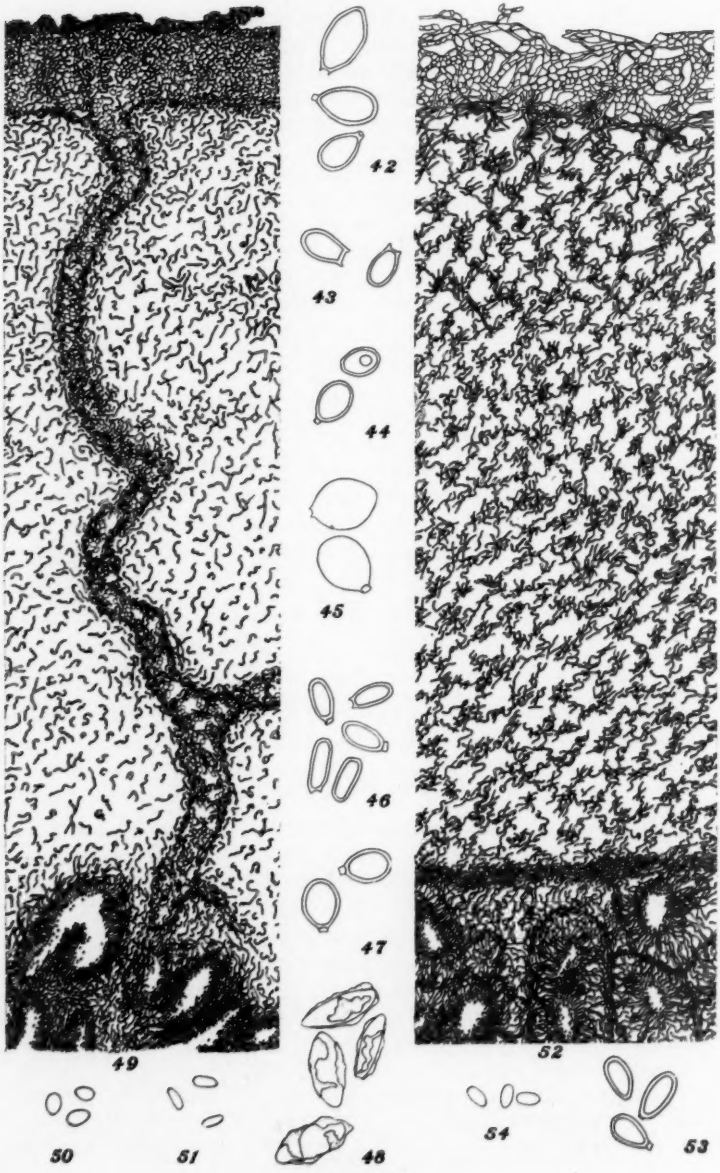
Lloyd (Myc. Notes **64**: 987. 1920) described 3 layers in the peridium. The inner one, however, is distinctly a part of the fertile glebal tissue or the arrested pseudoparenchymatous fundament of a receptaculum. Lloyd described no columella and in addition states that "The African species differs in not having the tramal plates. . . ." It is true that the sterlie branches from the base are not as prominent as in *Protubera Maracuja*. There are, however, very definite sterile plates and it seems to the writer that *P. africana* is well within the scope of the genus as described by Möller. This genus belongs in that developmental series which we are including in the Protophallaceae.

CALVARULA gen. nov.

Fructificationes subsphaericae; peridio tenui, strato externo e hyphis dense intertextis, peridium tramalem crassum gelatinosum, laminis radiantibus interruptum investienti; gleba primo carnosa, dein brunneola sporarum sine capillitia pulvere repleta, postremo excavata; sporis levibus, brunneis.

Fructifications subspherical, peridium an outer rind of fundamental tissue overlying a thick layer (tramal peridium) of loosely interwoven hyphae embedded in a gelatinous matrix, through which very thin plates of fundamental tissue radially and unbrokenly connect the peridium with an inner thin layer of fundamental tissue next to the gleba; gleba fleshy, becoming a brownish powdery, homogeneous spore-mass without capillitium; spores smooth, brown *en masse*.

TYPE SPECIES: *Calvarula excavata*.



FIGS. 42–54.

26. **Calvarula excavata** sp. nov.

Fructificationes subsphaericae, circa 1.5 cm. crassae, superficie coactiliioidea vel fibrillosa, molli alba, colori brunneo foedata; peridio tenui, hyphis magnis intricatis composito, peridium tramalem 1.5–3 mm. crassum, gelatinosum laminis radiantibus interruptum investiente; gleba primo carnosa, dein brunneola, sine capillitio, pulvere sporarum repleta, postremo excavata; sporis brunneolis, levibus, ellipsoideis vel ovoideis, 3–3.5 × 1.7–2.2 μ.

Fructifications subspherical, up to 1.5 cm. in diameter; surface felty to fibrillose, flaking off, soft, chalky white, staining more or less brownish (where bruised?), changing brown in preservative; peridium thin, of loose, coarse hyphae having occasional clamp-connections, covering a tramal peridium 1.5–3 mm. thick of very fine, hyaline hyphae embedded in a gelatinous matrix through which thin plates of fundamental tissue (cortical plates) radially connect unbrokenly the peridium with an inner thin layer of fundamental tissue next to the gleba; gleba at maturity of brownish, powdery, homogeneous spore-mass without capillitium; spores subhyaline (brown *en masse*), smooth, ellipsoid to ovoid, 3–3.5 × 1.7–2.2 μ (FIG. 35).

Among leaves on boggy farm hummock, Cocount Grove, Florida, *R. Thaxter,* Nov., 1897, type (in Farlow Herb., Harvard Univ.).

There are three very mature fructifications in the type collection of *C. excavata.* They are shrunken in the preservative but when transferred to water for a time regained their original size. Other than the field note given by Dr. Thaxter there is no information concerning the glebal structure and dehiscence. In preservative the gleba is about all dissolved from the chamber it once occupied (FIG. 10), leaving the peridial shell, so to speak; hence the specific name. It may be this description is founded on insufficient material. Nevertheless, the characters presented by the material indicate quite definitely the trends in the mode of development. Young stages, however, are desirable to reveal the exact nature of the gleba. No remains of important sterile tissue are apparent within the gleba.

As may be seen in figures 9 and 10 the "cortical plates" (Burt [9]), or plates of fundamental tissue which have unbroken

[9] Burt, E. A. Development of the receptaculum of *Clathrus columnatus* Bosc. Bot. Gaz. **22**: 273–292. *illus.* 1896.

connection between the fundamental tissue of the rind (peridium) and a similar thin layer inside of the thick gelatinous layer are delineated as shallow furrows on the outer surface of the peridium and the inner surface of the tramal peridium (volva) like sutures joining the bones of a skull (FIG. 34); hence the generic name, *Calvarula,* a small skull.

The division of the gelatinous layer (volva) by these cortical plates (sutures) is indicative of the type of development of the fruit body. Sutures from the base extend in more or less straight plates up two-thirds or more of the distance to the summit, but divide the upper portion into sectors. This is similar to the condition in egg stages of genera of the Clathraceae, *Calvarula* being most similar to early stages of certain species in *Colonnaria* and *Clathrella.* Since no receptaculum is developed in *Calvarula,* the genus is referred to the Protophallaceae.

PROTOPHALLUS Murrill, Mycologia **2**: 25. 1910.

Experience with a second species in this genus indicates that important morphological characters have been omitted from the description of the genus. This was undoubtedly due to the extreme maturity of the type collection, described at some length by Murrill. Through the kindness of Dr. W. C. Coker, the writer has obtained specimens preserved in liquid. These were collected by Dr. Coker at Cinchona, Jamaica, in 1900, nine years previous to the type collection. Examination of the type of *Protophallus jamaicensis* proved it to be congeneric with a distinctly different species collected by the late Dr. R. Thaxter at Buenos Aires, Argentina, in 1906.

Both species, however, have relatively thin, membranous peridia overlying thick gelatinous layers of fine loose hyphae embedded in a gel. This heavy gelatinous layer may be referred to as the tramal peridium and the thinner membranous outer layer as the fundamental or primary peridium, or as "peridium" for short.

The tramal peridium in these two species is not continuous. It is interrupted by radial plates or sutures composed of the same type of fundamental tissues as are found in the two peridia. These sutures have unbroken connections with the peridia and the gleba as is true in the button stages of genera within the family Cla-

thraceae of the Phallales. Murrill did not describe these sutures through the tramal peridium, but he described them at extreme maturity as "hyaline membranes," *i.e.*, "gleba . . . attached to hyaline membranes projecting from the inner surface of the peridium at regular intervals and floating free at maturity in a hyaline, gelatinous liquid." He states further, "The membranous plates to which the spore-masses were attached were as regular in arrangement as the partitions of an orange, but they did not extend to the center."

In both species of *Protophallus* there is a columella which reaches to the center of the fructification.

The description of the genus is therefore emended as follows to include the above morphological characters:

Fructifications epigeous, sessile, usually from a long cord-like rhizomorph, globose; peridium thin, membranous, overlying a thick gelatinous tramal peridium interrupted by radial membranous plates which have unbroken connection with the peridium and gleba; columella cylindrical, extending from the basal rhizomorph to the center of the fructification; gleba hysterangioid, sectored by percurrent plates or membranes from the columella, gelatinous; hymenium lining walls of cavities; basidiospores minute, ellipsoid, colored.

Type species is *Protophallus jamaicensis* Murrill, Mycologia **2**: 25. 1910.

The emended description of the type species is as follows:

27. PROTOPHALLUS JAMAICENSIS Murrill.

Fructifications spherical, up to 4 cm. in diameter, surface viscid, smooth, avellaneous, becoming white at maturity; peridium 200–280 μ thick, of rather densely interwoven hyaline hyphae in a gelatinous matrix, covering a gelatinous tramal peridium, about 1–1.5 mm. thick, composed of fine hyaline hyphae very loosely dispersed through a gelatinous matrix, and interrupted by radial membranous plates (sutures) of the same structure as the primary peridium and having unbroken connection with the latter and the gleba; columella cylindrical, extending from the basal rhizomorph to the center of the fructification, gelatinous with a cartilaginous core; gleba hysterangioid, olivaceous, sectored by percurrent, radial, gelatinous membranes or plates from the columella the sectors attached to the tramal peridium by the sutures;

cavities small, localized in the sectors, almost filled with spores; basidia not seen; spores oblong-ellipsoid, smooth, olivaceous, 3.0–4.3 × 1.2–1.8 μ (FIG. 51).

The second species in the genus is:

28. **Protophallus brunneus** sp. nov.

Fructificationes sphericae, 1.5–3.5 cm. crassae, appendici radiciformi adfixae, superficie alba vel sordida, levi sed leniter coactoidea, leniter reticulata; peridio tenaci, circa 175–250 μ crasso, hyphis hyalinis, intertextis, composito, peridium tramalem gelatinosum, circa 2–4 mm. crassum, laminis radiantibus interruptum investiente; columella alba, stratis externis cartilaginis, intus gelatinosa, ad centrum fructificationis extendente, lamellis gelatinosis radiantibus ex fructificationis axe ortis; gleba hysterangioidea, pallido-olivaceo-brunnea vel caryophyllo-brunnea; locellis parvis; septis tenuibus, hyphis gelatinosis intertextis compositis; basidiis elongato-clavatis, 4–6-sporis; sporis lato-ellipsoideis, cumulo brunneis subhyalinis *sub lente*, 5–6 × 2.5–3 μ.

Fructifications spherical, 1.5–3.5 cm. in diam., attached below by a single cord-like rhizomorph, surface white becoming sordid, smooth but somewhat felt-like, reticulated by a few lines (FIG. 3, 4); peridium thin, tough, about 175–250 μ thick, composed of interlacing and anastomosing hyaline hyphae, surrounding a gelatinous tramal peridium which is about 2–4 mm. thick (usually thickest below) and composed of an open-meshed anastomosing network of fine hyaline hyphae embedded in a gel, and through which radial cortical plates (sutures) have unbroken connection with the peridium and gleba; columella white, cord-like, with a tough cartilaginous sheath and gelatinous core, extending from the basal rhizomorph to about the center of the gleba, and from the summit of which radiate slate-colored, gelatinous plates to the tramal peridium (FIG. 49); gleba hysterangioid, light-olive-brown to clove-brown; cavities rather small; septa thin, of interwoven, gelatinized hyphae; basidia elongate-clavate; 4–6-spored; spores broadly ellipsoid, brown *en masse*, subhyaline under microscope, 5–6 × 2.5–3 μ (FIG. 50).

In a park, Buenos Aires, Argentina, February and March, 1906, *R. Thaxter*, type (in Farlow Herbarium, Harvard University).

Protophallus brunneus differs from *P. jamaicensis* Murr. in several ways. The surface of the latter has a soft, smooth, viscid feel while that of the former has a felty roughness to the touch and is marked off distinctly by a few reticulate lines which are the superficial expression of the cortical plates (sutures). The gleba

of *P. jamaicensis* is more gelatinous and is dusky drab to blackish-brown and that of *P. brunneus* is light-olive-brown to clove-brown. The spores of the former are narrowly ellipsoid or bacillar and 3–4 × 1.2–1.8 μ (FIG. 51) while the spores of *P. brunneus* are broadly ellipsoid, rounded at both ends and 5–6 × 2.5–3 μ.

29. RHOPALOGASTER TRANSVERSARIUS (Bosc) Johnston.

Material of this interesting genus came to hand after the manuscript and plates for this paper were otherwise finished. Illustrations of spores and relation of gleba to peridium are therefore not included for comparison. A rather casual examination of the microscopic characters gives no less assurance than Johnston [10] claimed for its inclusion among the *Hysterangiaceae*. It is definitely a brown-spored form with less gelatinous-cartilaginous tissues than in most of the other representatives of the Hysterangiales except that group of brown-spored species which have been referred tentatively to *Hysterangium*, namely *H. occidentale* Harkn., *H. neglectum* M. & R., *H. neocaledonicum* Pat., and perhaps *H. album*. *Rhopalogaster* is an aberrant genus perhaps branching from the main line of development near these brown-spored species of *Hysterangium*.

Tentative keys to the families and genera of the Hysterangiales, which the writer has had opportunity to study, are included herewith.

KEY TO FAMILIES OF THE HYSTERANGIALES

I. Tramal peridium continuous, thick, gelatinous.
1. Gelopellaceae (one genus, *Gelopellis*).

II. Tramal peridium not continuous.
A. Tramal peridium not well developed or if so, cartilaginous, thin, interrupted by fertile or infertile cavities usually not filled by peridial tissue.....2. Hysterangiaceae.
B. Tramal peridium thick, gelatinous, interrupted by thin plates of peridial tissue having unbroken connection with the fundamental peridium and sectors of the gleba.....3. Protophallaceae.

KEY TO GENERA OF THE HYSTERANGIACEAE

I. Columella simple, thick, percurrent.....1. *Rhopalogaster.*
II. Columella cushion-like, or thin and much branched, but not percurrent.
A. Peridium with thick, warty or head-like, sterile outgrowths.
2. *Phallobata.*

[10] Johnston, J. R. On *Cauloglossum transversarium* Fries (Bosc). Amer. Acad. Arts & Sci., Proc. **38**: 59–74. *illus.* 1902.

B. Peridium more or less uniformly thick.
a. Fructifications more or less globose, not stalked, hypogeous.
3. *Hysterangium.*
b. Fructifications pear-shaped, stalked, epigeous.....4. *Phallogaster.*

KEY TO GENERA OF THE PROTOPHALLACEAE

I. Gleba a powdery mass at maturity.....1. *Calvarula.*
II. Gleba gelatinous-cartilaginous at maturity.
A. Columella much branched from near the base, dividing the gleba into sectors. .....2. *Protubera.*
B. Columella simple, extending to the center of the fructification, with branches from the summit dividing the gleba into sectors.
3. *Protophallus.*

30. **Secotium diminutivum** sp. nov.

Fructificationes 8–9 mm. altae; pileo conico vel angusto-ovoideo, 4–5 mm. alto, 3–4 mm. lato, glabro, albo dein argillascente; stipite 3–4 mm. longo, 0.5–1.0 mm. crasso, albo dein sordido, glabro, sursum in columellam tenuem percurrentem procurrente; peridio 175–280 μ crasso, strato simplici hyalino prosenchymatico constito; gleba alba dein sordida; locellis parvis, plerumque e columella radiantibus; septis tenuibus, hyphis tenuibus, hyalinis, compactis compositus; cystidiis nullis; basidiis, cylindraceis, prominentibus, tetrasporis; sporis subsessilibus, hyalinis, fusiformibus, infra subtruncatis, levibus sed in utriculo saepe diffracto inclusis, 12–16 × 5–6 μ.

Fructification 8–9 mm. tall; pileus conical or narrowly ovoid, 4–5 mm. high, 3–4 mm. broad, smooth, white becoming clay-color (FIG. 12); stipe 3–4 mm. long, 0.5–1.0 mm. in diam., white becoming sordid, smooth, extended above into a slender, nearly percurrent columella (FIG. 13); peridium 175–280 μ thick, of a single hyaline, prosenchymatous layer; gleba white becoming sordid; cavities mostly radiating from the columella, small; septa thin, of very compact, parallel, slender, hyaline hyphae; cystidia none; basidia cylindrical, projecting above the hymenium, 4-spored (sometimes 2-spored); spores almost sessile, hyaline, fusiform, quite truncate below (as *Hysterangium* spores), smooth when young, but with a utricule which is often ruptured at maturity, 12–16 × 5–6 μ (FIG. 48).

Under old oak leaves on the ground, north of Corvallis, Benton County, Oregon, *S. M. Zeller,* April 21, 1937, type.

EXPLANATION OF FIGURES

The drawings in the following figures were prepared by Mrs. D. P Rogers.

FIG. 1. Exterior of fructification of *Truncocolumella citrina.* × 1.

FIG. 2. Median vertical section of fructification of *T. citrina*, showing the relation of stump-like columella and gleba. × 1.

FIG. 3. Exterior of fructification of *Protophallus brunneus*. The depressions indicate the position of the cortical plates within. × 2.

FIG. 4. Median vertical section of fructification of *P. brunneus*, showing relation of parts. × 2.

FIG. 5. Exterior of mature fructification of *Truncocolumella rubra*. × 1.

FIG. 6. Median vertical section of the fructification shown in figure 5. Notice the stump-like columella. × 1.

FIG. 7. Exterior view of a fructification of *Gelopellis macrospora*. × 2.

FIG. 8. Median vertical section of the fructification shown in figure 7. Notice the thick continuous gelatinous envelope (tramal peridium) surrounding the black gleba. × 2.

FIG. 9. Exterior of a mature fructification of *Calvarula excavata*, showing the depressions which indicate the position of the sutures which divide the gelatinous tramal peridium within. × 2.

FIG. 10. Median vertical section of the fructification shown in figure 9. The gleba is gone leaving the hollow volva or tramal peridium. Lines on the interior show the position of the sutures. × 2.

FIG. 11. Exterior of a fructification of *Rhizopogon separabilis* showing the separation of the peridium. × 1.

FIG. 12. Exterior of a fructification of *Secotium diminutivum*. × 2.

FIG. 13. Median vertical section of the fruiting body shown in figure 12. × 2.

FIG. 14. Radial section through the peridium and gleba of *Rhizopogon exiguus*, showing structure and relation of tissues. × 42.5.

FIG. 15. Spores of *R. exiguus*. × 825.

FIG. 16. Radial section through the peridium and gleba of a young fructification of *Truncocolumella citrina*. × 42.5.

FIG. 17. Radial section through the peridium and gleba of *Rhizopogon separabilis*. × 42.5.

FIG. 18. Spores of *R. separabilis*. × 825.

FIG. 19. Radial section through peridial and glebal tissues of *Hydnangium ellipsosporum*. × 42.5.

FIG. 20. Spores of *H. ellipsosporum*. × 825.

FIG. 21. Radial section through the exterior and glebal tissues of *Truncocolumella rubra*. × 42.5.

FIG. 22. Spores of *T. rubra*. × 825.

FIG. 23. Spores of *T. citrina*. × 825.

FIG. 24. Radial section through peridial and glebal tissues of *Dendrogaster olivaceus*. × 42.5.

FIG. 25. Spores of *D. olivaceus*. × 825.

FIG. 26. Radial section through peridial and glebal tissues of *Hydnangium setigerum*. × 42.5.

FIG. 27. Spores of *H. setigerum*. × 825.

FIG. 28. Radial section through peridial and glebal tisues of *Rhizopogon Thaxteri*. × 42.5.

FIG. 29. Spores of *R. Thaxteri*. × 825.

FIG. 30. Radial section through peridial and glebal tissues of *Melanogaster macrocarpus*. × 42.5.

FIG. 31. Spores of *M. macrocarpus.* × 825.

FIG. 32. Radial section through peridial and glebal tissues of *Hysterangium Darkeri.* × 42.5.

FIG. 33. Spores of *H. Darkeri.* × 825.

FIG. 34. Radial section of the peridium and gelatinous tramal peridium of *Calvarula excavata,* with one cortical suture dividing the gelatinous layer. × 42.5.

FIG. 35. Spores of *C. excavata.* × 825.

FIG. 36. Spores of *Gastrosporium simplex.* × 825.

FIG. 37. Spores of *Melanogaster luteus.* × 825.

FIG. 38. Spores of *M. Parksii.* × 825.

FIG. 39. Spores of *M. mollis.* × 825.

FIG. 40. Spores of *M. ambiguus.* × 825.

FIG. 41. Spores of *M. rubescens.* × 825.

FIG. 42. Spores of *M. tuberiformis.* × 825.

FIG. 43. Spores of *M. durissimus.* × 825.

FIG. 44. Spores of *M. variegatus.* × 825.

FIG. 45. Spores of *M. eurys permus.* × 825.

FIG. 46. Spores of *M. Broomeianus.* × 825.

FIG. 47. Spores of *M. intermedius.* × 825.

FIG. 48. Spores of *Secotium diminutivum.* × 825.

FIG. 49. Radial section through the peridium, gelatinous tramal peridium and a portion of the gleba of *Protophallus brunneus.* One of the cortical plates (sutures) is included. × 42.5.

FIG. 50. Spores of *P. brunneus.* × 825.

FIG. 51. Spores of *P. jamaicensis.* × 825.

FIG. 52. Radial section through the peridium, gelatinous envelope and a portion of the gleba of *Gelopellis macrospora.* × 42.5.

FIG. 53. Spores of *G. macrospora.* × 825.

FIG. 54. Spores of *G. Thaxteri.* × 825.

BITZEA, A NEW GENUS IN THE PUCCINIACEAE [1]

E. B. Mains

In 1936 the writer obtained two collections of rust on species of Inga in the El Cayo District of British Honduras.[2] These possesed abundant telia containing sessile, one-celled, colorless, thin-walled teliospores. Associated in one of the collections were pycnia with circinating uredinia, the urediniospores irregularly reticulated with prominent longitudinal ridges. The uredinia resembled the primary uredinia of *Ravenelia Ingae* (P. Henn.) Arthur as described in North America Flora (**3**). Although pycnia, primary and secondary uredinia have been described for *R. Ingae,* telia are unknown. The question therefore arose whether the telia of the British Honduran specimens were connected with the uredinia. If so the rust would not be a species of *Ravenelia.*

These questions necessitated a study of collections of *Ravenelia Ingae* and other rusts of *Inga.* Through the kindness of Dr. George B. Cummins the collections of the Arthur Herbarium have been available for study. Dr. Cummins had noted the occurrence of one-celled teliospores on a number of these specimens and he very generously has allowed me to use his notes.

Forty-three collections of rust on species of *Inga* have been studied. Of these 15 have borne telia containing one-celled, hyaline teliospores. Of these 13 have been associated with uredinia of the type described as primary uredinia for *Ravenelia Ingae.* This therefore indicated that these are stages of one species and that it has been erroneously placed in the genus *Ravenelia.*

The study also raised another question. Secondary uredinia have been described (**3**) for *Ravenelia Ingae.* It is stated that these deform the shoots and are confluent in large irregular

[1] Papers from the Department of Botany and the Herbarium of the University of Michigan.

[2] This expedition was mostly supported by funds from the Horace H. Rackham School of Graduate Studies of the University of Michigan.

patches on the leaves. The spores are described as smaller than the primary urediniospores and echinulate.

Of the 43 collections studied 12 have pycnia and primary uredinia only; 12, pycnia, primary uredinia and telia; 3, pycnia, primary uredinia, and secondary uredinia; 1, pycnia, primary uredinia, secondary uredinia, and telia; and 15, secondary uredinia only. In the collection having pycnia, primary uredinia, secondary uredinia, and telia, the telia are more closely associated with the primary than with the secondary, the latter occurring mostly on different leaves. One would expect that in a species having primary and secondary uredinia that the telia would be most commonly associated with the secondary uredinia. Here the telia occur almost entirely in association with primary uredinia. This indicates that the secondary uredinia belong to a separate species. At least it would seem best to so consider them until telia have been found associated so that they can be definitely placed. Such a treatment raises a question concerning the specific name applicable to each.

Uredo Ingae was described by Hennings (**7**) from collections of E. Ule from Brazil. Hennings states that the uredinia cause a deformation of the branches, shoots, and fruits. A portion of the type (Ule *1591*) has been available for study. The urediniospores are ellipsoid or obovoid, 14–16 × 18–24 μ, the wall 1.5–2 μ, thickened at the apex, 2–4 μ and moderately echinulate. This rust is similar to the secondary uredinia described under *Ravenelia Ingae* in the North American Flora.

Uromyces ingicola was described by Hennings (**8**) from a collection of Ule (*2929*) on *Inga* sp. from Rio Juruá, Brazil. Hennings described verrucose urediniospores and one-celled, colored teliospores which had the wall longitudinally striate. Only a fragment of the type has been available for study. It bears a few uredinia apparently associated with pycnia. The urediniospores are similar to those described for the primary uredinia under *Ravenelia Ingae*. They are somewhat variable in markings and thickening of the wall at the apex and at the base. Hennings' teliospores were without question urediniospores. However, teliospores occur on the type. They are old and most have germinated. They are one-cell, hyaline, smooth and very thin-walled. An-

other collection collected by Puttemans (*646*) on *Inga* sp. at Sao Paulo, Brazil and reported by Hennings (**9**) as *Uromyces Ingicola* has furnished more satisfactory material. The urediniospores are obovoid, 16–20 × 20–30 μ, the walls irregularly reticulated with the longitudinal ridges most prominent. Telia also occur on this specimen. The teliospores are sessile, clavate-cylindric, 11–16 × 70–90 μ, the wall hyaline, very thin.

Uredo excipulata was described by the Sydows in 1904 from one of Pringles' collections of *Inga Inicuil* from Mexico. This apparently was taken from a phanerogamic specimen. According to the diary of Pringle published by Helen Burns Davis (**6**) a collection of *Inga Inicuil* (*8134*) was made April 13, 1899, at Jalapa. Dr. W. R. Maxon has very kindly examined this collection in the United States National Herbarium and has sent me several leaves bearing the rust. This agrees with a portion of the type in the Arthur Herbarium. The uredinia form circles around the pycnia. The urediniospores are obovoid, 16–18 × 24–38 μ, the wall 2 μ, thickened at the apex, 3–6 μ. The markings of the urediniospores differ somewhat from those of *Uromyces ingicola*. They are poorly developed, occurring as short broken lines mostly on the upper and lower portions of the spores, the equatorial zone generally being smooth. Telia were not found on either specimen.

In 1907, Arthur (**1**) transferred *Uredo Ingae* to *Ravenelia* citing *Uredo excipulata* as a synonym. However, only pycnia and uredinia were described. Apparently the transfer was based on the prevalence of species of *Ravenelia* with somewhat similar uredinia on species of the Leguminosae. The Sydows (**15**) in their monograph accepted this and when in 1921, H. Sydow (**11**) proposed a division of *Ravenelia* into eight genera, he transferred *Ravenelia Ingae* to *Haploravenelia*.

Uromyces porcensis was described by Mayor in 1913 from a collection on *Inga* (cf) *ingoides* from the Dept. of Antiagua in Colombia. He described pycnia and teliospores. This collection has not been available for study but it is evident from Mayor's description and figures that the teliospores were urediniospores of the primary uredinial type.

Ravenelia Whetzelii was described by Arthur (**2**) in 1917 from collections of rust on *Inga vera* made by Whetzel and Olive in

Puerto Rico. Only pycnia and uredinia were described. The uredinia of the type (*206*) are in circles around the pycnia. The urediniospores are 18–26 × 31–42 μ, the walls 2.5–3 μ thickened at the apex 5–6 μ and some at the base, and very strongly irregularly reticulated with the longitudinal ridges most prominent. No telia were found. One collection (*207*) cited by Arthur has in addition to pycnia and uredinia of the type described, secondary uredinia of the type of *Uredo Ingae*. Another collection (*208*) bears telia in addition to pycnia and primary uredinia. The teliospores are clavate-cylindric, 14–20 × 100–130 μ, sessile, the wall hyaline and very thin.

Arthur (**2**) in his discussion of *Ravenelia Whetzelii* states that a collection on *Inga pachycarpa* from Quito, Ecuador in 1892 distributed by G. Lagerheim under the unpublished name of *Uromyces Ingae* is also *R. Whetzelii*. An examination of this collection shows pycnia, primary uredinia, and telia similar to those of collection *208*.

In 1925, Arthur (**3**) redescribed *Ravenelia Ingae*. Pycnia, primary and secondary uredinia were described and it is stated that telia are unknown.

One-celled, hyaline teliospores have been described for two rusts of *Inga*, *Maravalia Ingae* Sydow, and *Maravalia utriculata* Sydow, *Maravalia Ingae* was described in 1925 by Sydow from collections of F. L. Stevens made in British Guiana (*715*, type) and Trinidad (*790*). Only telia were described and the teliospores are given as one-celled, hyaline, thin-walled and pedicellate. A study of the portions of these collections from the Arthur Herbarium and the Herbarium of the University of Michigan shows that the teliospores are sessile, clavate-cylindric, 16–20 × 90–110 μ, hyaline, very thin-walled. These teliospores therefore agree very closely to those which have been found with the primary uredinia described under *Ravenelia Ingae*. This has been substantiated through the discovery of uredinia. One group of uredinia was found on a portion of the type collection received from the Farlow Herbarium through the kindness of Dr. David H. Linder. Uredinia were also located on portions of the Trinidad collection received from the University of Illinois through the kindness of Dr. Neil E. Stevens, and from Pathological and

Mycological Collections of the United States Bureau of Plant Industry through the kindness of Mr. John A. Stevenson. The urediniospores are broadly obovoid to ellipsoid, 16–22 × 26–32 μ, the walls 2 μ, thickened up to 5 μ at the apex, irregularly longitudinally rugose with the ridges somewhat broken and with occasional somewhat indistinct crossridges.

Maravalia utriculata was also described in 1925 by Sydow from a collection (*279*) from Costa Rica on *Inga* sp. Only telia were described. A portion of this collection from the Arthur Herbarium has been available for study. The teliospores are similar to those of *Maravalia Ingae*. Uredinia also were found on this collection and the urediniospores agree with those found in collections of *M. Ingae*.

It is evident that *Maravalia Ingae* and *M. utriculata* are names applied to the telial stage of a rust which has pycnia and primary uredinia of the type first described under the name *Uromyces ingicola*. However, the genus *Maravalia* is based on *Maravalia pallida* Arth. which has teliospores with well developed pedicels. In this respect the rust under discussion is more closely allied with species of *Chrysocelis*. The genus *Chrysocelis* is based on *Chrysocelis Lupini* Lagerh. & Dietel which has pycnia, aecia, and telia. The pycnia are subepidermal, the aecia with catenulate spores but without a peridium and the teliospores sessile, hyaline and thin-walled. The *Inga* rust has a very different primary stage, uredinia with pedicellate spores. This is a difference in life cycle which is not generally accepted as a generic distinction. However, the subcuticular pycnia of the *Inga* rust justify an establishment of a new genus for the species.

Excluding, *Uredo Ingae* for the reason previously given, the species has been described under the following names arranged in chronological order. *Uromyces Ingicola* Henn., *Uredo excipulata* Sydow, *Uromyces porcensis* Mayor, *Ravenelia Whetzelii* Arth., *Maravalia Ingae* Sydow, and *Maravalia utriculata* Sydow. According to article 57 of the International Rules of Nomenclature (**5**), a species of the Uredinales must bear the earliest specific name which has been given, starting with Persoon's Synopsis, to the state containing the form which it has been agreed to call the perfect form. The perfect state for the Uredinales is

defined as that which ends in the teleutospore or its equivalent. There has been some difference of opinion concerning what constitutes the perfect state. Arthur (**4**) would interpret it as the sporophytic state in which case specific names based on secondary uredinia (uredia) would be valid. It is evident from the examples cited in the International Rules that it was not intended that uredinial names should take precedence over those applied to the telial stage.

The rust under discussion has been described twice in the genus *Uromyces* as *U. ingicola* and *U. porcensis*, teliospores supposedly being described for both. In both instances these were primary urediniospores. It has been described once as a species of *Ravenelia, R. Whetzelii*. Telia were not described, only pycnia and primary uredinia. For *Uredo excipulata* only pycnia and primary uredinia were described. Therefore even according to Arthur's interpretation of the International Rules these names would be excluded because they were applied to a spore form belonging to the gametophytic state. Telia were described and the name *Maravalia Ingae* published in Mycologia November 1, 1925, and under the name *M. utriculata* in Annales Mycologici December 31, 1925. The former therefore determines the specific name.

The following arrangement is proposed.

Bitzea[3] gen. nov.

Pycnia subcutularia; uredinia subepidermalia; urediniosporae pedicellatae; telia subepidermalia; teliosporae inter se liberae, sessiles, hyalinae, statim germinantes.

Bitzea Ingae (Sydow) comb. nov.

Uromyces ingicola P. Henn. Hedwigia **43**: 157. 1904.
Uredo excipulata Sydow, Ann. Myc. **2**: 350. 1904.
Uromyces porcensis Mayor, Mém. Soc. Neuch Sci. Nat. **5**: 459. 1913.
Ravenelia Whetzelii Arth., Mycologia **9**: 64. 1917.
Uromyces Ingae Lagerh. ex. Arth., Mycologia **9**: 65. 1917.

[3] The Indian name bitze is used for *Inga edulis* in some parts of the American tropics.

Maravalia Ingae Sydow, Mycologia **17**: 257. 1925.
Maravalia utriculata Sydow, Ann. Myc. **23**: 314. 1925.

Pycnia amphigenous, mostly epiphyllous, crowded in small groups, subcuticular, discoid, 100–200 μ across, 24–35 μ thick.

Primary uredinia amphigenous, crowded, surrounding the pycnia often forming a more or less continuous circle, subepidermal, deep seated in somewhat hypertrophied tissue, partially covered by the overarching tissue leaving only a slit, pulverulent, cinnamon-brown; urediniospores somewhat variable in size and markings, broadly obovoid or ellipsoid, 14–26(30) × (20)24–48(55) μ, the wall cinnamon-brown, 2–4 μ, more or less thickened at the apex 3–8 μ, sometimes thickened at the base, usually rugose-reticulated, the somewhat irregular longitudinally ridges prominent and the cross ridges less pronounced, in a few collections with ridges broken and even disappearing from the equatorial portion, the germpores 3–4, equatorial.

Telia hypophyllous, white, small, 0.1–0.5 mm. and sometimes confluent, usually crowded in small groups, sometimes scattered, subepidermal; teliospores sessile, clavate or clavate-cylindric, 12–20 × 70–140 μ, the wall hyaline, very thin, 0.5 μ, germinating at once.

The following specimens have been examined.

Inga edulis Mart. San Felipe, Guatemala, Jan. 14, 1917, E. W. D. Holway, *719*, also *Uredo Ingae*; El Cayo, British Honduras, June 16, 1936, E. B. Mains, *3508*.

Inga Inicuil Cham. & Schlecht. Jalapa, Mexico, Pringle (type of *Uredo excipulata*); Jalapa, Mexico, April 13, 1899, C. G. Pringle, *8134* (from phanerogamic specimen *342857* in the United States National Museum, probably same as the preceding).

Inga insignis H. B. K. Valle Chiche, Quito Ecuador, Sept. 2, 1920, E. W. D. & Mary M. Holway, *962*.

Inga laurina (Sw.) Willd. El Junque, Puerto Rico, April 14, 1916, Whetzel and Olive, *209*; Maricao, Puerto Rico, March 24, 1916. Whetzel and Olive, *210*.

Inga leptopoda Benth. San Jose, Costa Rica, Jan. 8, 1916, E. W. D. Holway, *389*, also *Uredo Ingae* and Jan. 10, 1916, *400*; San Jose, Costa Rica, Feb. 1924, Paul C. Standley, *33287*, also *Uredo Ingae*.

Inga pachycarpa Benth. Quito, Ecuador, Jan. 1892, G. Lagerheim (*Uromyces Ingae* Lagerh. ex. Arth.); Ambato, Ecuador, Abelardo Pachano, *25*.

Inga pinetorum Pittier, San Agustin, British Honduras, Aug. 13, 1936, E. B. Mains, *4133*.

Inga Preussii Harms. San Salvador, Salvador, March 30–April 24, 1922, Paul C. Standley, *22461*.

Inga vera Willd. El Gigante near Adjuntas, Puerto Rico, July 16, 1915, F. L. Stevens, *8509*; Maricao, Puerto Rico, March 25, 1916, H. H. Whetzel & Edgar W. Olive, *205*; Mayaguez, Puerto Rico, H. H. Whetzel & Edgar W. Olive, *206* (type of *Ravenelia Whetzelii* Arth.); Maricao, Puerto Rico, Whetzel & Olive, March 23, 1916, *207*, also *Uredo Ingae* and March 24, 1916, Whetzel & Olive *208*; Rio Prieto, Puerto Rico, June 20, 1924, Whetzel, Kern, Toro, *2185, 2401* and July 7, 1924, *2384*.

Inga sp. Rio Juruá, Brazil, June, 1901, Ule *2929* (type of *Uromyces ingicola* Henn.); Sao Paulo, Brazil, Puttemans, *646*; San Jose, Costa Rica, Dec. 26, 1915, Holway, *295*; Pinheiros, Sao Paulo, Brazil, March 27, 1922, E. W. D. & Mary Holway, *1684*; Altoda Serra, Brazil, June 14, 1922, E. W. D. & Mary Holway, *1968*; Vreedon Hoor, British Guiana, Jan. 8, 1922, F. L. Stevens, *715* (type of *Maravalia Ingae* Sydow); Coverden, Trinidad, Aug. 12, 1922, F. L. Stevens, *790*; La Caja near San Jose, Costa Rica, Sydow *279* (type of *Maravalia utriculata* Sydow).

Secondary uredinia may rarely be produced. A few were noted which apparently were not associated with pycnia. These contained urediniospores which were similar to those of the primary uredinia. Some collections differed considerably from the average in urediniospore size and markings. At one extreme are collections with urediniospores measuring 20–30 × 40–55 μ, with very pronounced rugose-reticulations. And at the other, collections with urediniospores measuring 16–18 × 24–33 μ, with markings poorly developed and often missing in the equatorial zone. *Uredo excipulata* Sydow is in the latter group. Although this is a considerable difference, there are collections showing various graduations between these extremes and it seems best to consider them as one species.

It is difficult to obtain accurate measurements of the teliospores. Apparently as soon as they reach full size they germinate and collapse. Others take their place. As a result the telia are made up of a mass of collapsed teliospores and spores in various stages of development.

As already stated the secondary uredinia of the type of *Uredo Ingae* Henn. are excluded. They may possibly be the secondary uredinia of *Bitzea Ingae* but the evidence appears to be against it. It seems best to list collections of this type under the name of *Uredo Ingae* until telia are found definitely associated. This rust may be described as follows.

UREDO INGAE P. Henn. Hedwigia **38** (69): 1899

Ravenelia Ingae Arth. N. Am. Flora **7**: 132. 1907.
Haploravenelia Ingae Sydow, Ann. Myc. **19**: 165. 1921.

Uredinia caulicolous causing considerable deformation, on the leaves usually developing as large effused patches; urediniospores ellipsoid or obovoid, 13–19 × 18–26 μ, the wall 1.5–2 μ somewhat thickened at apex, 3–6 μ, echinulate, the pores 3–4, equatorial.

Inga edulis Mart. Chinautta, Guatemala, Feb. 12, 1916, Holway *486*; San Felipe, Guatemala, Jan. 14, 1917, Holway, *719,* also *Bitzea Ingae;* Rio de Janeiro, Brazil, Aug. 13, 1921, E. W. D. & Mary Holway, *1031,* Rel. Holw. *269.*

Inga leptopoda Benth. San Jose, Costa Rica, Jan. 8, 1916, Holway, *389,* also *Bitzea Ingae,* and Jan. 17, 1916, *486*; San Jose, Costa Rica, Feb. 1924, Paul C. Standley, *33287,* also *Bitzea Ingae.*

Inga Preussii Harms. San Salvador, Salvador, S. Calderon, Arth. Herb. No. *44614.*

Inga vera Willd. Ponce, Puerto Rico, Aug. 1904, O. W. Barrett; Monte Montosa, Puerto Rico, Oct. 13, 1912, F. L. Stevens, *g 76,* and Oct. 14, 1912, *28 d*; Monte Alegrillo, Puerto Rico, June 20, 1913, F. L. Stevens, *2376*; Maricao, Puerto Rico, March 23, 1916, Whetzel & Olive, *207,* also *Bitzea Ingae*; Adjuntos, Puerto Rico, July 15, 1924, Whetzel, Kern & Toro, *2371*; Ciales Road, Puerto Rico, Whetzel, Kern & Toro, *2372*; Maricao-Mayagues Road, Puerto Rico, July 8, 1926, Whetzel,

Kern & Toro, *2376*; San Cristobal, Puerto Rico, March 4, 1926, Kern & Toro, *90*.

Inga sp. St. Cathar. Blumenau, São Francisco, Brazil, E. Ule, *1591* (type of *Uredo Ingae* Henn.); Petropolis, Rio de Janeiro, Brazil, Dec. 20, 1921, E. W. D & Mary M. Holway, *1235*.

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SOME FUNGI IMPERFECTI FROM THE PACIFIC NORTHWEST [1]

RODERICK SPRAGUE [2] & WM. BRIDGE COOKE [3]

(WITH 2 FIGURES)

The fungi discussed or described in this article were collected either on Mt. Shasta, Siskiyou County, California, or in western Oregon. Specimens are deposited in the Mycological Herbarium of the Department of Botany at Oregon State College, Corvallis, Ore. Portions also have been deposited in the Mycological Collections of the Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C. All of the collections bear the Oregon State College numbers and those collected on Mt. Shasta have, in addition, the collector's numbers.

RAMULARIA DELPHINII Jaap

A fragmentary collection from Mt. Shasta (O. S. C. *8349*, W. B. Cooke *8574*) on *Delphinium pauciflorum* Nutt. was made in the chaparral at an elevation of about 5,000 feet, July 9, 1937. The fungus caused gray-white, sub-circular lesions which macroscopically resembled lesions due to downy mildew. The spores measured 15–25 × 5–7 μ thus corresponding to Jaap's measurements (10–35 × 4–7.5 μ). The type of *R. Delphinii* Jaap was found in the Swiss Alps at an elevation of 1,200 meters (3,900 feet). It was described by Jaap in 1913 (**4**) two years before *R. Delphinii* Dearness and House (**3**) was described, and there-

[1] Coöperative investigations by the Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture, and the Department of Botany, Oregon Agricultural Experiment Station, Corvallis, Oregon. Published as Technical Paper No. 284 of the Oregon Agricultural Experiment Station.

[2] Associate Pathologist, Division of Cereal Crops and Diseases, Bureau of Plant Industry, U. S. Department of Agriculture.

[3] Custodian of the Shasta Alpine Lodge, Mount Shasta, California, and Graduate student, Department of Botany, Oregon State College, Corvallis, Ore.

fore the latter species was renamed *R. Sheldoni* Trotter (**8**). The spores of *R. Sheldoni* measure 15–33 × 4–5 μ.

Dr. House has very kindly furnished material of *R. Delphinii* Dearn. and House for comparison with the Shasta material. The lesions on the latter are, as mentioned, gray and downy while the former has arid, light tan lesions with distinct brown borders. Since the material of *R. Delphinii* Dearn. and House had very few spores and the material from Shasta was downy with them, it is possible that the morphological difference as shown by symptoms may not be of great significance. Further material is needed to show whether *R. Sheldoni* Trotter (*R. Delphinii* Dearn. and House) is distinct from *R. Delphinii* Jaap. The Shasta material at least, is clearly referable to *R. Delphinii* Jaap.

It is of interest to note that there are two other species of *Ramularia* described on *Delphinium* that may be synonyms of Jaap's fungus: *Ramularia albowiana* Siemaszko which was described in 1919 (**9**) has spores measuring 20–42 × 5–7 μ. It was found in the Caucasus region. *R. brevipes* Sacc. has slightly smaller spores (20–28 × 4–5 μ) and it is stated by Saccardo (**7**) that this species is very distinct. The entire group needs study where type material is available.

RAMULARIA SENECIONIS (Berk. & Br.) Sacc. var. CARNIOLICA Jaap

A collection of a leaf spot on *Senecio lugens* Rich var. *exaltus* Gray on Mount Shasta (O. S. C. *8479, 8480, W. B. Cooke 8584*) is referable to the above name. The spores measure 18–33 × 4.3–5.5 μ (FIG. 1, *A*), as compared with 25–40 × 4–7 μ for the conidia from Jaap's varietal type. *R. Senecionis* (Berk. and Br.) Sacc. is said to have smaller spores (13–22 × 3–4 μ) which are sometimes septate.

An examination of prepared sections of the material from Mt. Shasta shows that the prominent conidiophores of the fungus continue to aggregate forming a definite acervulus-like growth which is eventually pushed out and partially replaced by spherical compact fruiting bodies. These appear to be immature and from their content are probably immature perithecia. These bodies are very numerous, prominent and scattered in the outer periphery

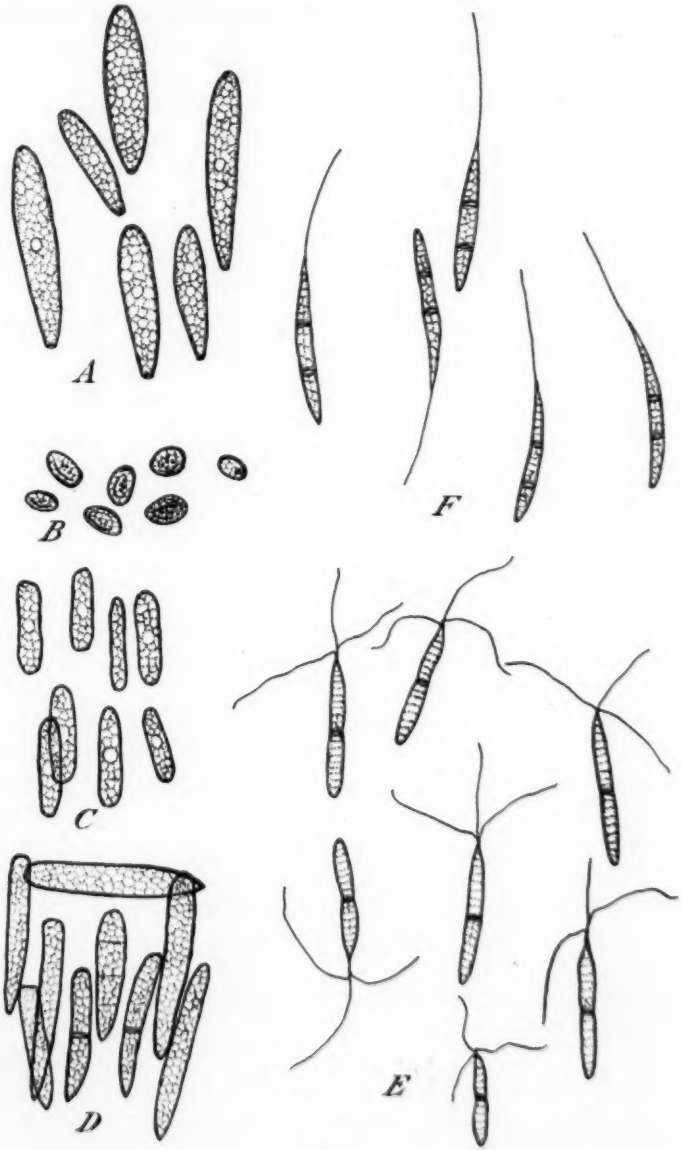

FIG. 1.

of the lesions. The same bodies are noted in material collected by C. L. Shear (*924*) at Telluride, Colorado (West American Fungi, *332*).

The collection from Mount Shasta is similar to *Gloeosporium Senecionis* Ellis and Ev., *G. Senecionis-cordati* Allescher as well as a number of species of *Ramularia* described on *Senecio*. Without available type material for comparison the fungus is tentatively assigned to Jaap's variety, but its affinity with both *Gloeosporium* and *Ramularia* is considered worthy of note.

Naemosphaeria shastensis Sprague & W. B. Cooke, sp. nov.

Pycnidiis conspicuis, gregariis, globosis, erumpentibus-superficialibus, rostello brevi cylindrico, nigris, ostiolatis, contextu parenchymatico densissimo, 250–360 × 300–450 μ; pycnosporulis numerosis, ellipticis v. ovoideis v. subglobosis, brunneis, 3–3.4 × 4.5–6.5 μ.

Hab. in foliis et culmis emortuis *Streptanthi tortuosi* Kellogg var. *orbiculati* Hall.

Pycnidia conspicuous, gregarious, globose, erumpent-superficial, with a short, cylindrical beak, ostiolate, 250–360 × 300–450 μ diam., context densely parenchymatous. Pycnospores numerous, elliptical to ovoid to subglobose, brown 3–3.4 × 4.5–6.5 μ (FIG. 1, *B*).

On dead leaves and stalks of *Streptanthus tortuosus* Kellogg var. *orbiculatus* Hall. Type: O. S. C. *8351, W. B. Cooke 8542,* Mt. Shasta, Calif., June 28, 1937; O. S. C. *8346,* W. B. Cooke *8589,* Mt. Shasta, Calif., July 20, 1937.

The fungus is confined to plants growing in springy places and was found as soon as the snow had melted. The pycnidia, which arise from the epidermis, are large and prominent with a distinct cylindrical, sometimes eccentric, beak. Cross sections of the pycnidia disclose a great mass of small, light-brown spores (FIG. 1, *B*) surrounded by the rindlike, relatively thin, cell wall of the pycnidium. In crushed mounts the pycnidia float free as shells analogous to the way perithecia of the Erysiphales behave on being crushed.

Placosphaeria shastensis Sprague & W. B. Cooke, sp. nov.

Stromatibus non maculiculis, dispersis vel rarius gregariis, leptothyrioideis, ellipticis v. irregularibus, 150–350 × 200–1,000 μ diam.; loculis variabilibus,

plus minusve confluentibus, subglobosis v. irregularibus, contextu carbonaceis, nigris; sporophoris hyalinis, 11–16 × 2 μ; sporulis bacillaribus rectis, apice rotundatis, hyalinis, 9–14 × 2.5–4 μ.

Hab. in caulibus emortuis *Monardellae odoratissimae* Benth. Mt. Shasta, California, June 24, 1937. Type: O. S. C. *8472, W. B. Cooke 8509.*

Stroma not in spots, dispersed or less often gregarious, leptothyrioid, elliptical to irregular, 150–350 × 200–1,000 μ in diameter, locules variable, more or less confluent, subglobose to irregular, context carbonaceous, black; sporophores hyaline, 11–16 × 2 μ; spores straight bacillar or cylindric, apices rounded or semi-squared, hyaline, 9–14 × 2.5–4 μ (FIG. 1, *C*).

This fungus occurs on old overwintering stems of *Monardella odoratissima* Benth. at an elevation of 8,000 feet at Horse Camp The fungus is associated with *Pleospora permunda* M. C. Cooke and *Stemphylium* sp.

MACROPHOMA CYLINDROSPORA (Desm.) Berl. & Vogl.

Punctiform pycnidia are abundant on dead and necrotic leaves of *Phlox Douglasii* Hook. collected on Mt. Shasta at an elevation of 8,000 feet (O. S. C. *8459*, W. B. Cooke *8553*) in midsummer, 1937. The spores are similar to those in the illustration of *M. cylindrospora* given by Grove (**1**) although many of them vary from the paliform cylindrical-truncate form in Grove's illustration. In addition, a few spores are one-septate and others give indication of becoming eventually three septate. However, most of the spores have clear, nonguttulated contents (FIG. 1, *D*). They measure 17–22 × 2.7–4.5 μ thus slightly exceeding the measurements as given for *M. cylindrospora* which, however, appears to be a polymorphic species. This is the first report of the fungus on *Phlox*, one of the few reports of it on a semi-herbaceous plant, and possibly the first report from western America.

Robillarda Agrostidis Sprague, sp. nov.

Maculis diffusis, pycnidiis subcutaneis, sparsis, nigris, ostiolatis, globosis v. lenticularibus, 160–200 (60–450) μ diam. Pycnosporulis cylindraceis, rectis, utrinque attenuatis, basi rotundatis, medio 1-septatis, 17.5–20 × 2.6–3.3 μ, apice acutatis, 3–4 setaceis; setis 8–15 × ± 0.5 μ.

Hab. in foliis et vaginis dejectis, *Agrostidis tenuis.*

Pycnidia scattered, at first covered by the epidermis, later pseudosuperficial, black-brown, obscurely ostiolate, easily crushed

and the brittle thin shell consisting of polygonal, deeply pigmented, black-brown cells. Pycnidia extremely variable, as small as 60 μ in diam., mostly 160–200 μ, occasionally extremely elongate, 450 $\times$ 100 μ. Pycnospores 17.5–20 $\times$ 2.6–3.3 μ, hyaline, cylindric, moderately to not constricted at the single central septum, ends tapering, base rounded, tip acute tapering into a whip-like cilium which branches into three, rarely four, forks about 1 μ from the end of the cell. Cilia nearly equal in length to the main body of the spore (FIG. 1, *E*).

On dead, straw-colored leaves and sheaths of *Agrostis tenuis* Sibth., Corvallis, Benton Co., Oregon. Type: O. S. C. *42, R. Sprague,* Jan. 3, 1938.

Heteropatella alpina (Ellis & Ev.) W. B. Cooke, comb. nov.

Fungi referable to the above combination were collected on *Juncus* sp. (*W. B. Cooke 9305*) and on *Ligusticum Grayi* (*W. B. Cooke 8585*) in the Panther Creek Heather Meadows on Mount Shasta at an elevation of 8,000 feet.

The spores, which measure 32–45 $\times$ 2.4–3.5 μ, including an apical prolongation ⅓–½ their total length (FIG. 1, F), are borne in subsuperficial excipuliform pycnidia. According to Grove (**2**) these characters place the fungus in the genus *Heteropatella.*

The material from Mt. Shasta appears to be virtually identical with *Kellermannia alpina* Ellis and Ev. described originally on *Aquilegia coerulea* and other herbaceous plants at an elevation of 12,000 ft. in the Colorado Rockies, but in the same Merriam (**6**) life zone (Hudsonian) as where the Shasta specimens were collected.

Heteropatella alpina differs from *H. Bonordenii* (Hazl.) Lind in having narrower spores, with blunt broad bases, and its spores are borne on shorter, stouter, branched conidiophores, and asci are lacking among the conidiophores. *H. alpina* differs also from *H. umbilicata* (Pers.) Jaap in that the spores of the former have 2–3 septa while those of the latter have uniformly three septa.

The Shasta material differs from *Kellermannia alpina* only in the more robust fruiting bodies (up to 540 μ) and slightly longer spores. However, the fungus is apparently somewhat variable. The writer prefers Grove's classification and transfers the fungus

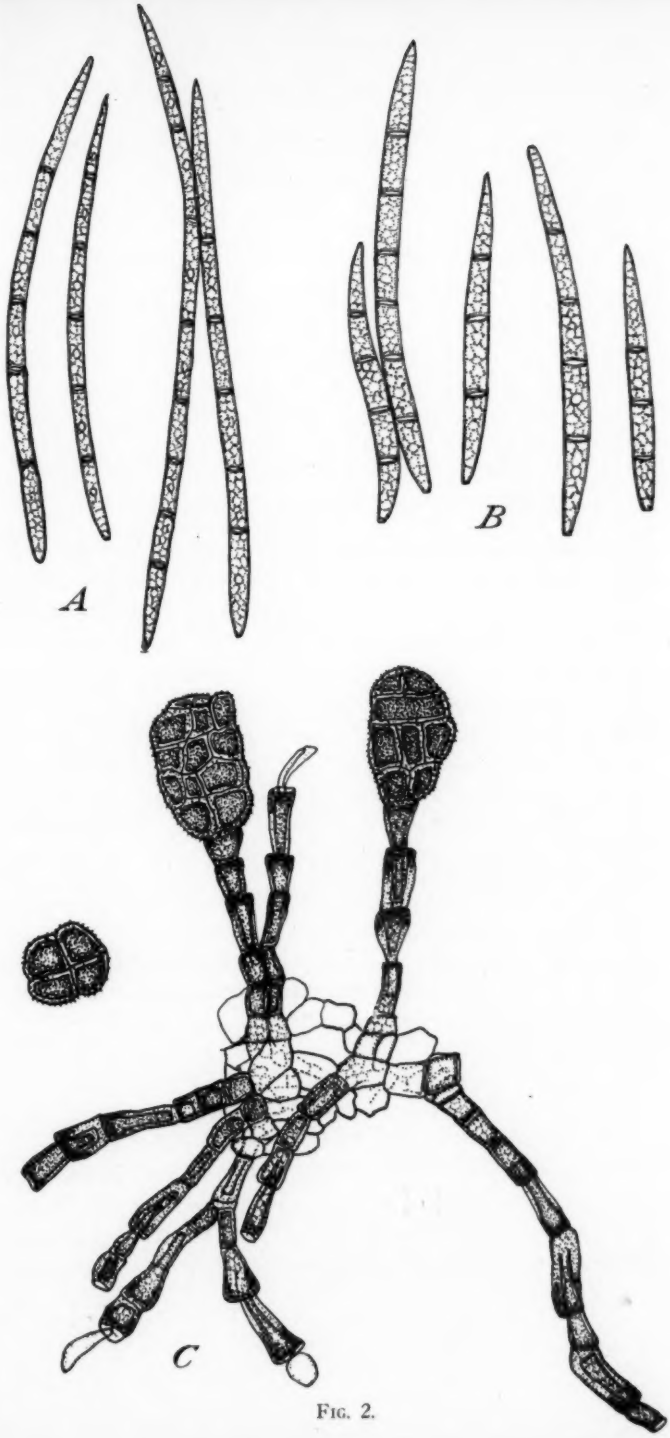

FIG. 2.

to *Heteropatella*. Further study, with abundant material, may show, as Grove suggests, that we are dealing with a polymorphic species.

Septoria Chlorogali (M. C. Cooke & Harkness) Sprague, comb. nov.

The fungus *Rhabdospora Chlorogali* M. C. Cooke and Harkness was collected on *Camassia Leichtlinii* Wats. near Irish Bend, Oregon (O. S. C. *8269*). The pycnospores measured 24–31 × 1.5–2.6 μ. The fungus is a species of *Septoria* and the above combination is proposed.

SEPTORIA MARGARITACEA Peck (Emended)

A collection of *Septoria* on *Anaphalis margaritacea* (L.) B. and H. made at Waldport, Lincoln Co., Ore., had spores measuring 29–55 × 2.4–3.5 μ (FIG. 2, *B*) and therefore appeared distinct from the description of *S. margaritacea* Peck which is listed with distinctly narrower spores measuring 40–80 × 1–2 μ. However, a comparison with the type material from White Lake, N. Y., kindly furnished by Dr. H. D. House, disclosed spores broader than given in the type description. They measured 40–77 × 2–2.7 μ (FIG. 2, *A*). The description is therefore emended to conform with the fragment of type material seen and to the material collected in Oregon. Fundamentally the Oregon material was similar to that from New York, the difference being only in length of spores.

Spots emarginate, ochraceous, becoming chestnut brown in the center, 0.5–2 cm. long. Pycnidia more or less numerous, epiphyllous, black, ostiolate, obscurely erumpent, 90–250 μ in diam. Pycnospores broadly filiform, 3–9 septate, curved to straight, commonly attenuate at apex and obtuse at base, 29–80 × 2–3.5 μ.

On living and dying leaves of *Anaphalis margaritacea* (L.) B. and H. White Lake, New York. Material collected at Waldport, Oregon, July 26, 1937 (O. S. C. *8410*), used in emended description. The Oregon material was the same as that of the type fragment except that the spores were shorter and broader (29–55 × 2.4–3.5 μ) and 3–6 septate (FIG. 2, *B*).

Macrosporium rosarium Penzig var. **Piscariae** Sprague, var. nov.

Maculis raris, rotundatis, isabellinis, griseis, epiphyllis margine angusto; hyphis fasciculatis, simplicibus, adscendentibus, 5–10 septatis, 50–105 × 6–10.5 μ, brunneis, ad septa inflatis, cellis pyriformibus vel urniformibus; conidiis acrogenis, forma et magnitudine variis, muriformibus, multiseptatis, ad septa plus minusve constrictis; episporio crasso, granuloso-echinulato, brunneo-olivaceis, 14–40 × 15–23 μ.

Hab. in foliis vivis *Piscariae setigerae* (Hook.) Piper.

Spots few, round, isabelline, gray, epiphyllous, margin narrow; conidiophores fascicled, simple, ascending, 5–10 septate, 50–105 × 6–10.5 μ, brown, cells of conidiophores inflated at septa, successively growing from the inner base of the previous lower cell, cells varying from pyriform to urn-shaped or nearly cylindrical. Conidia acrogenous, varying from nearly spherical to barrel-shaped, muriform and more or less constricted at the septa; major cross walls usually three, semi-deciduous from distal cell of conidiophore, partly tearing away from the endospore wall of distal cell from which the spore is separated by a late forming cross wall. Conidia brown-olive, minutely and thickly echinulate, 15–40 × 15–23 μ (FIG. 2, *C*).

On living leaves of *Piscaria setigera* (Benth.) Piper. South of Mary's River, Corvallis, Benton Co., Type: Ore. O. S. C. *10,916, H. S. Jackson,* Sept. 20, 1914.

This fungus is close to *Macrosporium rosarium* Penzig which is found on leaves of *Citrus limonum* in Italy. *M. rosarium* var. *Piscariae* differs in the longer couplings between the joints of the remarkably articulated conidiophores (FIG. 2, *C*), but, based on the description and the illustrations by Penzig (**5**), the writer fails to see how it differs sufficiently to warrant erecting a distinct species, notwithstanding the distinctly different hosts.

The writers are indebted to A. G. Johnson and Edith K. Cash of the Bureau of Plant Industry, U. S. Department of Agriculture, for kindly aid in the preparation of the manuscript.

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EXPLANATION OF FIGURES

All figures magnified × 1,000 except as noted.

FIG. 1. *A*, Conidia of *Ramularia Senecionis* var. *carniolica* on *Senecio lugens* var. *exaltus*. Mount Shasta (O. S. C. 8479); *B*, Pycnospores of *Naemosphaeria shastensis* (Type); *C*, Pycnospores of *Placosphaeria shastensis* (Type); *D*, Pycnospores of *Macrophoma cylindrospora* on *Phlox Douglasii*. Mt. Shasta, Calif. (O. S. C. 8459); *E*, Pycnospores of *Robillarda Agrostidis* (Type); *F*, Pycnospores of *Heteropatella alpina* on *Juncus* sp. Mt. Shasta (W. B. Cooke No. 9305).

FIG. 2. *A*, *Septoria margaritacea* on *Anaphalis margaritacea* from White Lake, N. Y. (Type); *B*, *S. margaritacea* on *A. margaritacea*, Waldport, Ore. (O. S. C. 8410); *C*, *Macrosporium rosarium* var. *Piscariae* (Type). Conidiophores bearing conidia (× 500).

OBSERVATIONS ON THE RATE OF GROWTH OF ASCOCARPS OF PEZIZA DOMICILIANA

S. M. Pady

During the past winter months ascocarps of a *Peziza* have appeared from time to time on the floor of a room in our residence. The mycelium was growing in the wood in a small section kept continually moist by the sweating of adjacent cold water pipes. The surface of the wood was slowly rotting, forming an ideal substratum for the growth and development of the fungus. The area in which the fruiting bodies were observed was a narrow strip about 12 inches long and ½ an inch or less in width, terminated by an open space about 1½ inches square, and bounded on one side by linoleum and on the other by a porcelain fixture. Although the ascocarps appeared only in this strip, the area invaded by the mycelium is probably more extensive since the moisture supply, while not large, was fairly constant and apparently adequate for the needs of the fungus. The number of mature ascocarps was usually small, ranging from one to four. As will be shown in Table I below, many young ascocarps appeared but very few managed to survive; in this case the food supply was probably the limiting factor. The temperature remained fairly high throughout the winter, the minimum being about 60° and the maximum about 80°. One window facing east supplied light, but since this opened onto a screened porch only a small amount of light reached the fungus. Ascocarps were first noticed in the fall of 1937 and continued to appear during the winter and spring. Whether or not fruiting bodies had appeared prior to this could not be determined. Commencing in January daily observations were made and records kept of (1) the total number of ascocarps and (2) the daily growth of maturing individuals. The fungus appears to be *Peziza domiciliana* Cooke, and agrees closely with Seaver's description.[1]

[1] Seaver, F. J. The North American Cup-Fungi, p. 230. 1928.

TABLE I

TOTAL NUMBER OF YOUNG AND MATURING ASCOCARPS

Date	No. Asco-carps	Remarks	Date	No. Asco-carps	Remarks
Jan. 20/38	11	All young	Mar. 14	4	(One dead)
Jan. 21	12	(One new)	Mar. 17	3	(One dying)
Jan. 23	5	(Remainder degenerated)	Mar. 21	6	(3 new ones)
Feb. 4	4	All mature by Feb. 7	Mar. 22	7	(1 new one)
Feb. 14	18	All very young	Apr. 11	5	3 later removed
Feb. 15	12	Young stages dying	Apr. 19	6	All later removed
Feb. 16	2*	One new one	Apr. 24	4	All later removed
Mar. 12	5	All small	May 4	6	

* Development of one of these given in Table II.

In Table I some of the observations of the total number of ascocarps in the field are given. Numerous young stages appeared about the same time; very few however, reached maturity. This is clearly shown in the series from Jan. 20 to Feb. 4. Of the 12 original ascocarps only four matured, one on Feb. 2, the others on Feb. 7. A second crop of young ascocarps then appeared on Feb. 14; subsequently all except one degenerated. Sometimes new individuals appear after the first main group, as for example on Feb. 16 when a new one appeared, but these usually degenerated also. On March 12 five additional ascocarps appeared, of which three went on to reach maturity about March 25. New ones appeared on March 21 and March 22, but these died in a few days. A survey of the field on April 11 showed five young stages; three of these were removed for study. Eight days later a new crop of six appeared, all of which were likewise removed. As a result, a second crop of four appeared five days later. This area thus produced a fairly regular succession of young stages, of which only a small number ever reached maturity.

Of the group of eighteen ascocarps appearing on Feb. 14 only one reached maturity. The daily development of this individual is shown in Table II. At first (Feb. 14) this ascocarp was more or less cylindrical in outline, but during the next two days the base gradually increased to about twice the diameter of the upper portion. Soon, however, the rapidly growing apothecium obscured the base, which became the stem. Growth was fairly uniform except on Feb. 18 when the increase was more rapid, due probably to an increase in the temperature of the room. The apo-

TABLE II

RATE OF GROWTH IN MILLIMETERS OF A SINGLE ASCOCARP

Time of Observation	Diameter			Height of Ascocarp	Daily Increase	
	Apothecium	Opening (Hymenium)	Base		Apothecium	Opening
Feb. 14, 10:00 P.M.	1½–2	—	–	—	–	–
Feb. 15, —	2	—	–	—	1	–
Feb. 16, 10:00 P.M.	3	—	6	—	1	–
Feb. 17, 10:00 P.M.	4	—	7	10+	1	–
Feb. 18, 10:00 P.M.	7	3	–	—	3	–
Feb. 19, 11:30 P.M.	8–9	4½	–	—	1½	1½
Feb. 20, 10:30 P.M.	10	6	–	—	1½	1½
Feb. 21, 10:30 P.M.	13	9	–	—	3	3
Feb. 22, 10:30 P.M.	17	13	–	—	4	4
Feb. 23, 10:30 P.M.	20	17	–	25	3	4
Feb. 24, 10:30 P.M.	25	22	–	26	5	5
Feb. 25, 10:15 P.M.	31	28	–	26	6	6
Feb. 26, 12:30 A.M.	45 × 42*	—	–	—	11–14	–
Feb. 28, 6:00 A.M.	60 × 45	—	–	—	13–15	–
Feb. 28, 10:30 P.M.	66 × 50	—	–	—	5–6	–
Mar. 1, —	75 × 50	—	–	—	5–9	–
Mar. 2, —	Preserved	—	–	—	—	–

* Apothecium became repand.

thecium retained its typical cup-shaped appearance until about the eleventh or twelfth day at which time it became repand and the diameter then increased tremendously. No observation was made at the regular hour on Feb. 27, but a measurement was taken at 6:00 A.M. on Feb. 28. At 10:30 P.M. the same day the ascocarp showed an increase in diameter of 5–6 mm. The mature ascocarps were typical with entire margin, often splitting, convex, umbilicate, hymenium dingy buff to brownish, stem yellowish-white.

The length of time required by the ascocarp shown in Table II to reach the mature condition was 16 days from the date of the first observation. In five other cases the length of time was 22, 27, 18, 16, 17 days respectively, the average length of all six being 20 days. Since nothing is known of the early stages of development or of the time required for these early stages it may be assumed that the total length of time required is somewhat longer. From these preliminary observations it is clear that under the above growing conditions *Peziza domiciliana* required about 20 days to complete its development and reach maturity.

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CONTRIBUTION TO KNOWLEDGE OF THE GENUS TAPHRINA IN NORTH AMERICA [1]

W. WINFIELD RAY [2]

(WITH 23 FIGURES)

This investigation was undertaken with the hope that critical study of some of the American species of *Taphrina* would contribute toward the ultimate preparation of the evidently much needed monograph of this important genus. Work was begun in 1936, and during its progress practically every American and European species has been examined. In this paper observations on some of the North American species occurring on *Alnus* and *Prunus* are presented.

Whenever possible fresh material has been employed for examination, but dried specimens, numbering over 500 in the Cornell University Herbarium, have been used also, especially for supplementary study. The writer has collected in abundance material of 12 valid species in the vicinity of Ithaca, New York. Many cultures have been made, 22 species having been obtained from fresh material collected by the author or forwarded by workers in other states.

The writer adopts the procedure of Giesenhagen (**1895**) in placing in the genus *Taphrina* all species formerly included in *Exoascus, Taphrina,* and *Magnusiella.* The genus *Magnusiella* as earlier proposed by Giesenhagen consists of species which later were transferred to the Protomycetaceae. The generic interpretations of *Exoascus, Taphrina,* and *Magnusiella* made by Sadebeck

[1] A portion of a thesis presented to the faculty of the Graduate School of Cornell University in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

[2] The writer wishes to express his indebtedness to Professor H. M. Fitzpatrick, under whom this investigation has been prosecuted, for the suggestion that it be undertaken, and for the advice and encouragement during its progress. Thanks are due the many workers from other institutions for making available specimens for examination.

(**1893**), were based on the presence or absence of a perennial mycelium, and are not practical for use in making taxonomic separations. The author feels that no noteworthy characteristics have been set forth which justify the use of more than one genus. Therefore, all species are placed in the genus *Taphrina*.

SPECIES OF TAPHRINA ON ALNUS

TAPHRINA ROBINSONIANA Gies.: This species commonly occurs on the bracts of the female catkins of *Alnus incana* (L.) Moench. and *A. rugosa* (Ehrh.) Spreng. in the central and eastern portions of North America during the summer months. The invasion of the subcuticular regions of the bracts brings about a hypertrophic condition of these organs (FIG. 15). In the early stages of infection the bracts are yellowish-green, later becoming yellowish-red or red.

The literature concerning *T. Robinsoniana* is scanty, in part because it is distinctly a North American species. In the monographic works of Robinson (**9**) and Patterson (**7**) the species is incorporated, but not under this name. Since the fungus does not occur in Europe, it is seldom mentioned in European monographs. The names, *T. amentorum, T. Alni-incanae,* and *T. alnitorqua* are most often employed for it, but none of them is synonymous with *T. Robinsoniana.* Because of the absence of this name in American monographs, and because of the difficulty of obtaining satisfactory mounts for microscopic study, improper choice of a name for the species was inevitable.

Robinson (**1887**) described the fungus correctly, mentioning its distortion of the bracts of female catkins of *A. incana.* However, he called it *T. alnitorqua* Tul. (*T. Tosquinetii* (West.) Magnus), a species which in Europe causes " witches'-broom " of *A. incana* and *A. glutinosa* Gaertn.

Patterson (**1895**) chose to call the fungus *Exoascus amentorum* Sad., because she found " no stalk cells." She listed as *E. amentorum* one specimen of the species sent to her by Dr. Farlow. This particular specimen collected at Newton, Massachusetts, was undoubtedly a portion of the material issued by Ellis in N. Am. Fungi *296,* and called *Ascomyces Tosquinetii* West. She failed to notice that it had a basal cell.

Giesenhagen (**1895**) studied Ellis' No. *296* and concluded that the fungus was not *T. amentorum* (Sad.) Rost., which does lack a basal cell, but was indeed a new species possessing a basal cell. He knew also that it was not *T. Tosquinetii.* He named it *T. Robinsoniana* in honor of Robinson who had first described the fungus.

Examinations of numerous fresh and dried collections indicate that *T. Robinsoniana* is responsible for the catkin disease of *A. incana* and *A. rugosa* during the summer. In no case has *T. amentorum* been encountered on these hosts. The limits of the many asci measured are 23–39 $\mu \times$ 7–11.5 μ. Basal cells are 11.5–19 μ long $\times$ 8–15 μ wide. Eight spored asci are common, although budding of the spores often results in a polysporic condition (FIG. 3).

In an alder swamp near Etna, New York, where *T. Robinsoniana* is common on the bracts of female catkins, two small collections of distorted, young shoots were made. The symptoms were manifested by a hypertrophic condition of the stem and leaves which had the yellowish to reddish color so common to infected catkin bracts. Microscopic examinations have demonstrated clearly that the fungus is *T. Robinsoniana.* The asci are smaller on the average than those from the diseased bracts, although the limits in size are nearly the same (FIG. 4). The results of many measurements show that the asci are 23–36 $\mu \times$ 7–9.5 μ; basal cells are 8–15.5 μ long $\times$ 8–13 μ wide. Isolates from diseased shoots are similar in every respect to those from diseased bracts.

SPECIMENS EXAMINED: Material from Canada, Nova Scotia, Massachusetts, Maine, Michigan, New York, and Wisconsin on *A. incana*; from Alabama, Delaware, Georgia, Virginia, and West Virginia on *A. rugosa.* The writer's herbarium contains 15 collections made by him in New York. In all, 40 specimens have been examined.

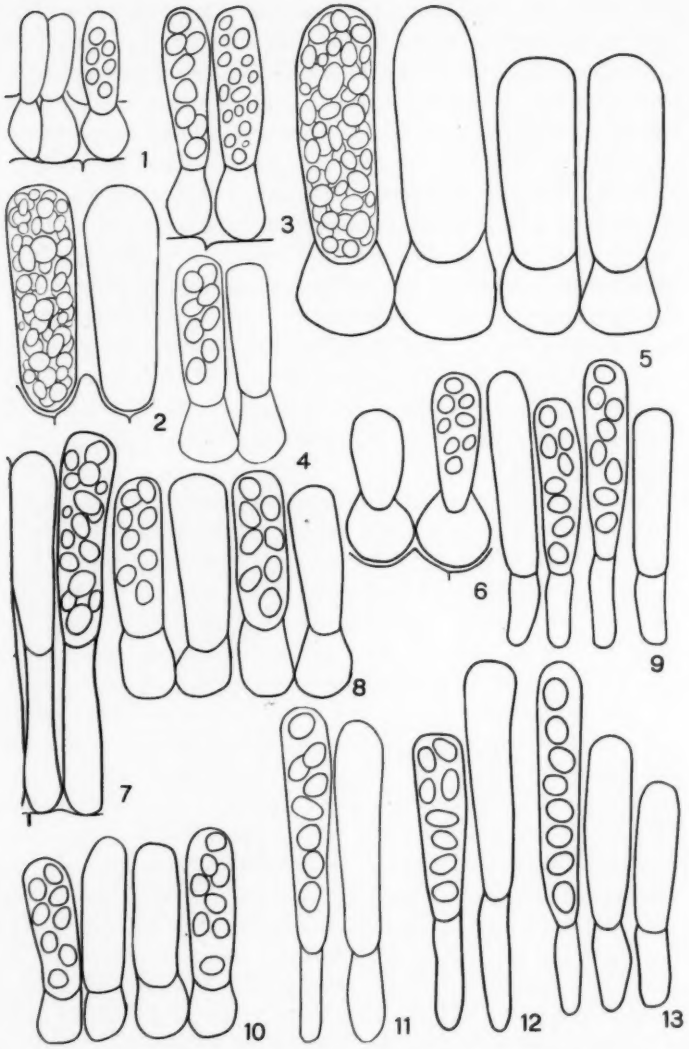
TAPHRINA AMENTORUM (Sad.) Rost.: For many years *Taphrina amentorum* has been known in Europe as the only species causing deformation of the bracts of female catkins of *Alnus incana* (L.) Moench. and *A. glutinosa* Gaertn. Since this fungus is so common in Europe, it has been thought that the species affecting aments of *A. incana* in North America is the same. As

has been pointed out above, *T. Robinsoniana* is, however, the only species occurring on *A. incana* in North America.

A search for *T. amentorum* among various collections has failed to disclose it as the cause of a catkin disease in this country. It has been discovered, however, on the bracts of fertile catkins of *Alnus oregona* Nutt. in a collection made in Alaska in 1899 by B. E. Fernow. This specimen was found in the collection of *Alnus* in the phanerogamic herbarium of the Department of Botany at Cornell University. Since *A. oregona* also occurs in the northwestern area of the United States, one might expect to find the fungus in this country, but the writer has no knowledge of its occurrence here. The fungus produces the same hypertrophic symptoms on the bracts of fertile catkins of *A. oregona* as those produced by *T. Robinsoniana* on *A. incana* (FIG. 15). The asci (FIG. 2) in this collection are 37–47 $\mu \times$ 10–12 μ. The asci are almost always polyspored.

Attempts at selection of the correct specific name for this fungus have long caused dispute. The writer feels that the matter should be settled, and to that end the history of the nomenclature of the species is outlined here. J. Kühn (**1873**) named a fungus deforming the bracts of fertile catkins of *Alnus* in Europe, *Exoascus alnitorquus* (Tul.) J. Kühn forma *Alni-incanae* Kühn in litt. His collection was issued in Rabenhorst, Fungi Europ. Exsic. XVII Cent. 1873, No. *1616*. Berkeley and Broome (**1876**), without actually describing it, discussed a fungus causing a disease of the female catkins of alder and named it *Ascomyces Alni*. This specific name had been used by DeBary in 1869 for another *Taphrina* on the leaves of alder, and hence could not be used by them. Rostrup (**1879**) called a fungus he found on the aments of *Alnus*, *Ascomyces Tosquinetii strobilina*. Thümen [3] in 1880 also collected this fungus and named it *Exoascus Alni* De Bary var. *strobilinus*. The specimen was issued in Mycotheca univ. XIV. Cent. 1879, No. *1366*. Sadebeck (**1888**), after making a microscopic study of the fungus, decided that it was an undescribed species and called it *Exoascus amentorum*. Although he gave no measurements of the asci, he pointed out that the ascus lacks a basal cell, a character which immediately separates it from all known forms

[3] Diagnosen zu Thümens "Mycotheca universalis." Flora **63**: 325. 1880.



FIGS. 1, *Taphrina rugosa*; 2, *T. amentorum*; 3, 4, *T. Robinsoniana*; 5, *T. occidentalis*; 6, *T. media*; 7, *T. Atkinsonii*; 8, *T. confusa*; 9, *T. flavorubra*; 10, *T. Farlowii*; 11, 12, 13, *T. communis*.

of *Taphrina* on alder. Magnus (**1890**) maintained that the name applied by Sadebeck had no standing because of the varietal name used by Kühn. He examined Kühn's collection and found no basal cell. He proposed, therefore, the name *T. Alni-incanae* (Kühn) Magnus, the name most commonly used today. It seems to the writer that Magnus was not justified in rejecting the name used by Sadebeck, even though, as some point out, the Sadebeck diagnosis does not constitute a formal description. The absence of a basal cell clearly sets the species apart from all others occurring on alder, and Sadebeck recognized and mentioned this distinguishing feature. Saccardo (Syll. Fung. **10**: 69) gives *E. Alni-incanae* Kühn in litt. as the correct name and places *E. amentorum* Sad. in synonymy. This name in the Sylloge has no standing, because a valid specific name already existed. In 1893 Sadebeck (**14**) gave an accurate description of this fungus and again called it *E. amentorum*. Rostrup (**1890**) accepted Sadebeck's name, but placed the species in the genus *Taphrina*. Therefore, the accepted name is *T. amentorum* (Sad.) Rost.

Taphrina rugosa sp. nov.

Hymenio subcuticulari; mycelio interiore carente; ascis cylindraceis, in apice rotundatis vel paulo truncatis, 14–28 μ longis × 4.5–9 μ crassis, circa 23 × 7.5 μ; cellula basalari plerumque ellipsoidea vel cylindracea, 8–14 μ longis × 6–10 μ crassis, circa 10.5 × 8 μ; sporidiis octonis vel paucioribus, ellipsoideis vel ovoidis, 2–4.5 μ diam.

DISTRIBUTION: Causing hypertrophy and deformation of the bracts of fertile catkins of *Alnus rugosa*. April and May. Georgia.

TYPE: In the herbarium of Department of Plant Pathology, Cornell University, No. *27346*.

SPECIMENS EXAMINED: The writer's herbarium contains 2 collections in addition to one collection of co-type material from Georgia.

In every April of the past three years, Dr. W. A. Jenkins of Experiment, Ga., has supplied me with diseased catkins of *Alnus rugosa* (Ehrh.) Spreng. In this material the subcuticular region of the bracts of fertile catkins was found to be invaded by an undescribed species of *Taphrina* which was causing a hypertrophic condition (FIG. 14).

This disease occurs early in the season when the catkins are developed little more than in the previous autumn. The bracts of *A. rugosa* affected by this new species seldom exceed 5 millimeters in length. In the case of *T. Robinsoniana* on *A. incana* and *A. rugosa*, the disease does not appear until the catkins are nearly mature, and infected bracts become 2–3.5 centimeters long.

The asci (FIG. 1) in this Georgia material also are small compared with those of most known species of *Taphrina* affecting alder. They are cylindrical with the apices rounded to nearly truncate. The basal cells are ellipsoidal in shape, and the sides are rounded unless lateral pressure from adjacent basal cells makes them straight. The base is usually rounded but may be nearly pointed. The spores are ellipsoidal to ovoid, and the number in all of the asci examined is eight, or less than 8.

Isolates of this fungus and *T. Robinsoniana* have been compared in culture under various conditions. On solid potato-dextrose media, they appear identical. Their temperature relations are, however, not the same. Isolates from *A. rugosa* grow more vigorously at temperatures of 3° C. and 6° C. as one extreme, and at 27° C. as the other, than do those of *T. Robinsoniana*. At 30° C. isolates of the new species remain viable for 15 days, whereas isolates of *T. Robinsoniana* remain viable for only 10 days or less. At this temperature isolates of the former species become slimy, while those of the latter do not.

When the two fungi are grown in a series of synthetic media, cultures which contain various carbon sources, used one at a time, it is found that often they do not utilize the same foods.

On the basis of morphology, time of infection, and culture characteristics, the author feels that the fungus affecting bracts of female catkins of *A. rugosa* during the early spring in Georgia is a new species and is distinct from *T. Robinsoniana*. He proposes to call it *Taphrina rugosa*.

Taphrina occidentalis sp. nov.

Hymenio subcuticulari; mycelio interiore carente; ascis cylindraceis vel paulo clavatis, in apice rotundatis, 34–54 μ longis × 10–20 μ crassis, circa 38–46 × 15 μ; cellula basalari, latiore quam longa, ad basim rotundata vel complanata, interdum intra cellulas epidermicales paulo extendati, 8–17 μ

alta × 12–22 μ crassis, circa 12 × 17 μ; sporidiis multis, sphaeroideis v. ellipsoideis, 1.5–4 μ × 2–6 μ.

DISTRIBUTION: Causing deformation and hypertrophy of bracts of fertile catkins of *Alnus oregona, A. rhombifolia,* and *A. tenuifolia* in western United States.

TYPE: In the herbarium of the Department of Plant Pathology, Cornell University, No. *10622.*

SPECIMENS EXAMINED: Nine collections of material from California, Idaho, Montana, and Oregon on *A. oregona, A. rhombifolia,* and *A. tenuifolia* were examined and are in the writer's herbarium.

While engaged in the examination of herbarium specimens of diseased catkins of *Alnus,* an undescribed species was discovered on distorted bracts of fertile catkins of *Alnus oregona* Nutt. The specimen, No. *10622,* in the herbarium of Department of Plant Pathology, Cornell University, was collected by J. A. Weir at Grants Pass, Oregon.

In the collection of *Alnus* in the herbarium of the Department of Botany at Cornell University, the same species was found on fertile catkins of *A. tenuifolia* Nutt. from Idaho and *A. rhombifolia* Nutt. from Oregon. Professor H. S. Jackson forwarded for study diseased catkins of *A. tenuifolia* from Montana, *A. rhombifolia* from California, and *A. oregona* from Oregon. Professor A. J. Mix sent collections made in California on *A. oregona* and in Idaho on *A. tenuifolia.* All show the same organism.

The diseased bracts are swollen, elongated, distorted, tongue-shaped, and red. The symptom picture is similar to that of the distorted bracts of *A. incana* affected by *T. Robinsoniana* (FIG. 15).

Although the fungus and *T. Robinsoniana* are alike in possessing a subcuticular mycelium and in the symptoms produced on their hosts, they are distinct morphologically. The new species has longer and broader asci than *T. Robinsoniana.* Its basal cells are as wide as they are long or even wider, a characteristic not common to *T. Robinsoniana* whose basal cells are almost always longer than wide.

The asci are cylindrical or slightly clavate and have rounded apices (FIG. 5). The basal cells never become inserted between

the epidermal cells to any extent. All asci observed contain numerous, ellipsoidal to sphaeroidal spores.

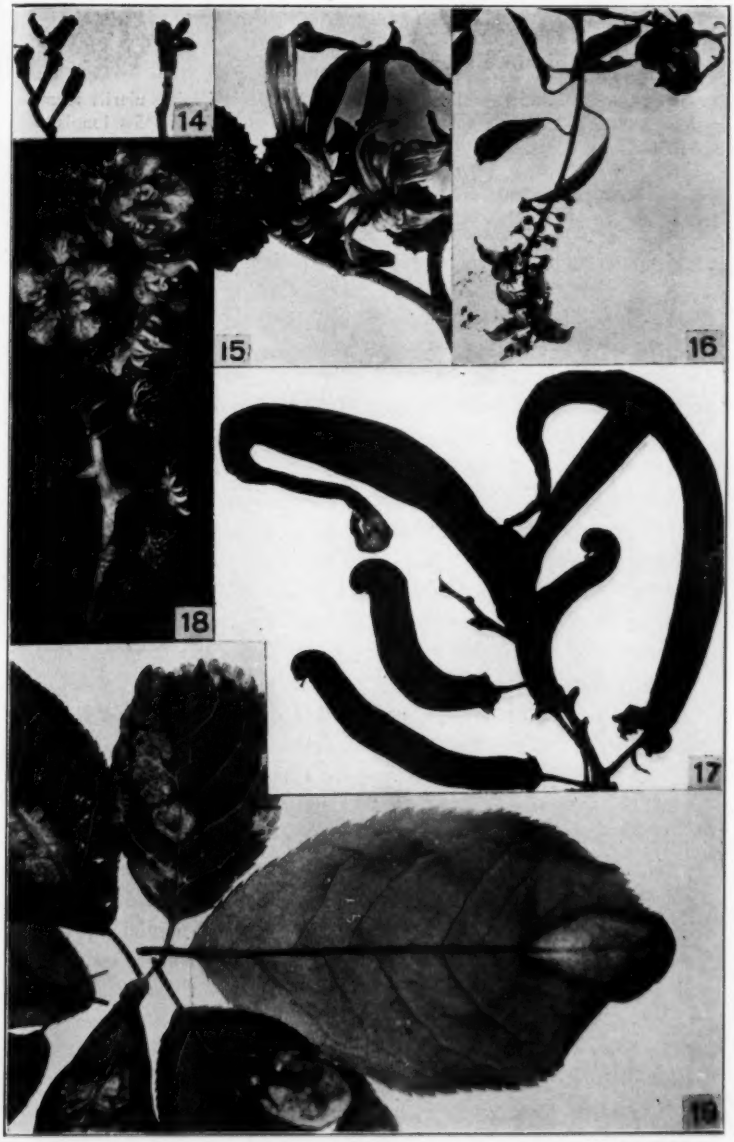
On the average, the asci and basal cells on diseased bracts of *A. oregona* are slightly larger than the same structures on *A. rhombifolia* and *A. tenuifolia* (FIG. 5). Because the limits in size of these structures are the same, and because the general morphology is similar in all collections, the writer, however, considers only one species of *Taphrina* as the cause of catkin disease of *Alnus* in western United States. Since the hosts are confined to that area, the author proposes the name *Taphrina occidentalis*.

TAPHRINA MEDIA Palm: A collection of leaves of *Alnus crispa* (Ait.) Purch. var. *mollis* Fern. affected by *Taphrina media* Palm was made June 26, 1929, by H. H. Whetzel and D. S. Welch near Hanover, New Hampshire. This fungus was described by Palm (**1917**) from a "witches'-broom" on *A. glutinosa* Gaertn. in Sweden. To the writer's knowledge this species has never before been reported in North America on any species of *Alnus*.

According to the collectors, a severe "witches'-broom" was not formed, but there was a tendency for the twigs to bend upward as in a typical "broom." Either the leaf was entirely affected by the fungus or only partially so. The margin of the leaf shows symptoms first, and by an invasion of the mycelium inward, the entire leaf becomes infected. Diseased areas are reddish-brown.

The length of the asci, according to Palm (**6**) is 25–90 μ. In his key to the species of *Taphrina* on *Alnus* the asci were reported, however, as 25–30 μ long. The latter measurements are correct, while the former represent apparently a typographical error. Saccardo (**24**: 1301–1302) repeated the typographical error.

Asci occur in the subcuticular regions on the upper and lower surfaces of the leaf. No vegetative mycelium exists in its interior. The asci (FIG. 6) are clavate with apices rounded or truncate, while the bases are narrowed and appear as if inserted into the basal cell. They are 19–27 μ long $\times$ 8–11 μ wide, the average size being 22 $\times$ 9 μ. Basal cells are almost spherical, but often the width exceeds the length. The size of these cells is 10–12 μ long $\times$ 10–15 μ wide.



FIGS. 14, *Taphrina rugosa;* 15, *T. Robinsoniana;* 16, *T. Farlowii;* 17, *T. Atkinsonii;* 18, 19, *T. confusa.*

SPECIES OF TAPHRINA ON PRUNUS

Taphrina Atkinsonii sp. nov.

Mycelio hymeniali subcuticulari; mycelio in spatiis intercellulariis abundante; ascis cylindraceis vel clavatis, in apice rotundatis, 38–45 μ longis × 8–11 μ crassis, circa 41 × 10 μ; cellula basalari cylindracea, ad basim rotundata, 28–40 μ longis × 5–8 μ crassis, circa 30 × 7 μ; sporidiis ellipsoideis vel globosis, octonis vel multis, 2.5–5 × 6–9 μ.

DISTRIBUTION: Causing deformation and hypertrophy of fruits and flower parts of *Prunus Capuli* in Mexico.

TYPE: In the herbarium of G. F. Atkinson which is filed as a unit in the herbarium of the Department of Plant Pathology, Cornell University, No. *21697*.

A collection of a new species of *Taphrina* affecting the fruits and flower parts of *Prunus Capuli* Cav. was found in the Atkinson Collection in the herbarium of the Department of Plant Pathology of Cornell University. The specimens were collected by Edward Palmer in San Ramon, Durango, Mexico, in 1906. Although the fungus was designated as a new species by Atkinson and a typewritten description was found within the packet, he failed to publish his observations. Since a search of the literature by the writer has failed to disclose any species like it, publication of our findings seemed desirable.

Due to hypertrophy, the affected fruits become 3–15 centimeters long and 6–10 millimeters in diameter. They are hollow, usually curved, often strongly so, or coiled into a small hook toward the apex (FIG. 17). Apparently the style and perianth parts may or may not be deformed.

The asci are cylindrical to slightly clavate and have rounded apices (FIG. 7). The basal cells, which are nearly cylindrical, have a rounded base. The spores are ellipsoidal to globose, each ascus containing eight to many spores. Vegetative mycelium is abundant throughout the intercellular spaces of the affected host tissues.

In honor of Professor Atkinson, the writer proposes for the fungus the name, *Taphrina Atkinsonii*.

TAPHRINA FARLOWII Sad.: From diseased fruits of *Prunus serotina* Ehrh. collected by Dr. Farlow at Cambridge, Mass., Sadebeck

(**1890**) described a new species, *Taphrina Farlowii*. The affected ovaries and flower parts become hypertrophied and are persistent (FIG. 16). This new species was accepted by many investigators, including Atkinson (**2**), Giesenhagen (**4**), and Patterson (**7**).

Sadebeck gave the measurements for the asci as 20–30 $\mu \times$ 8–9 μ and the basal cells as 15–25 $\mu \times$ 8–9 μ. Patterson (**7**) and Atkinson (**2**) found the length of the basal cell in specimens examined by them to be shorter than reported by Sadebeck. The writer finds that the asci are 20–35 $\mu \times$ 8–12 μ and the basal cells 6–18 $\mu \times$ 8–12 μ.

Atkinson (**1894**) described a new species causing a hyperplastic disease of leaves and shoots of *P. serotina* and called it *Exoascus varius*. This species, it was pointed out, differs chiefly from *T. Farlowii* in that it causes a leaf disease, whereas, the latter species causes fruit and flower deformation. He says, "the two forms, the one on the fruit and the one on the leaves, were so common on the same tree and so closely associated that many times I have been strongly inclined to consider them one and the same species. This inclination has been strengthened by a study of the structures of the fungus, for in many cases the asci and stalk cells on the leaves are very much like those of *E. Farlowii* on the fruits." Disregarding the morphological facts, he chose to call the fungus on the leaves *E. varius*.

Giesenhagen (**1895**) made *E. varius* a synonym of *T. Farlowii*. He gave no explanation for this action, but on the basis of morphology only he was justified in relegating it to synonymy.

Examinations of asci and basal cells from many collections of dried and fresh material has convinced the writer that only one species of *Taphrina* is the cause of disease of *P. serotina* (FIG. 10). These structures taken from the fruits were found to be slightly longer than those from the leaves, but the limits in size for them are the same.

Isolates obtained from diseased fruits and leaves were found to be alike macroscopically on solid potato-dextrose media, and growth responses at various temperatures were the same for all. Growth was slow at 0° C. and 3° C.; at 30° C. there was no response, while at 27° C. the rate of growth was almost normal. Young, active cultures remained viable less than two weeks at 30°

C. and for nearly 6 weeks at 27° C. Compared with many species of *Taphrina*, this fungus can not endure as high temperatures nor for so long a time.

Since the morphological and cultured characters of the fungi from fruits and leaves are identical, the writer recognizes only one species, *T. Farlowii*.

SPECIMENS EXAMINED: Material from Alabama, Delaware, Florida, Georgia, Kentucky, Massachusetts, North Carolina, and South Carolina has been examined.

TAPHRINA CONFUSA (Atk.) Gies.: Charles Peck (**8**) described a species of *Taphrina* which inhabited the leaves of *Prunus virginiana* L. and named it *Exoascus unilateralis*. The type specimen was collected at North Elba, Jefferson Co., New York, in 1897. He stated that the asci are always on the upper surface of the leaves and that their size is 40–50 $\mu \times$ 13–16 μ, while the basal cells are isodiametric, measuring 13–16 μ.

Examinations of a large number of specimens collected in the vicinity of Ithaca, New York, and Peck's collections listed as "Type I" and "Type II," have demonstrated clearly that asci commonly occur on both sides of the leaf and that their size is considerably smaller than stated in the original description. The writer finds that the asci are 25–40 $\mu \times$ 8–12 μ, the average length being 28–34 μ. The basal cells are usually longer than broad and measure 8–16 $\mu \times$ 7–13 μ.

Lesions, which are convex above and concave below, vary in size from those no larger than a few millimeters in diameter to others involving the whole leaf (FIG. 19). Diseased areas become yellowish to bright-red and waxy in appearance. Large lesions cause the leaf to fold inward. Occasionally tender shoots become infected, but their leaves may remain healthy. Mycelium occurs abundantly in the intercellular spaces of the leaf parenchyma. Normal leaf thickness seldom exceeds 140 μ, but in a lesion may reach 500 μ.

Taphrina confusa (Atk.) Gies. causes a hypertrophic disease of flower parts of *P. virginiana*. The organ most commonly affected is the pistil which becomes swollen and elongated. In many cases the stamens, perianth, receptacle, pedicel, and peduncle also become infected (FIG. 18). All hypertrophied organs are tan to flesh-

colored. Diseased flowers and leaves commonly have been found together and in both instances the fungus develops and matures at exactly the same time. The obvious question to be answered is, "are there two species of *Taphrina* causing disease in *P. virginiana* or only one?"

Microscopic examinations of the fungi from the various diseased organs of many collections reveals that the asci and basal cells in all cases are similar (FIG. 8). In general, the average size of these structures from leaves is slightly smaller than those from fruits and flower parts. However, the limits in size for all is the same, and, on the basis of morphology, only one species should be recognized.

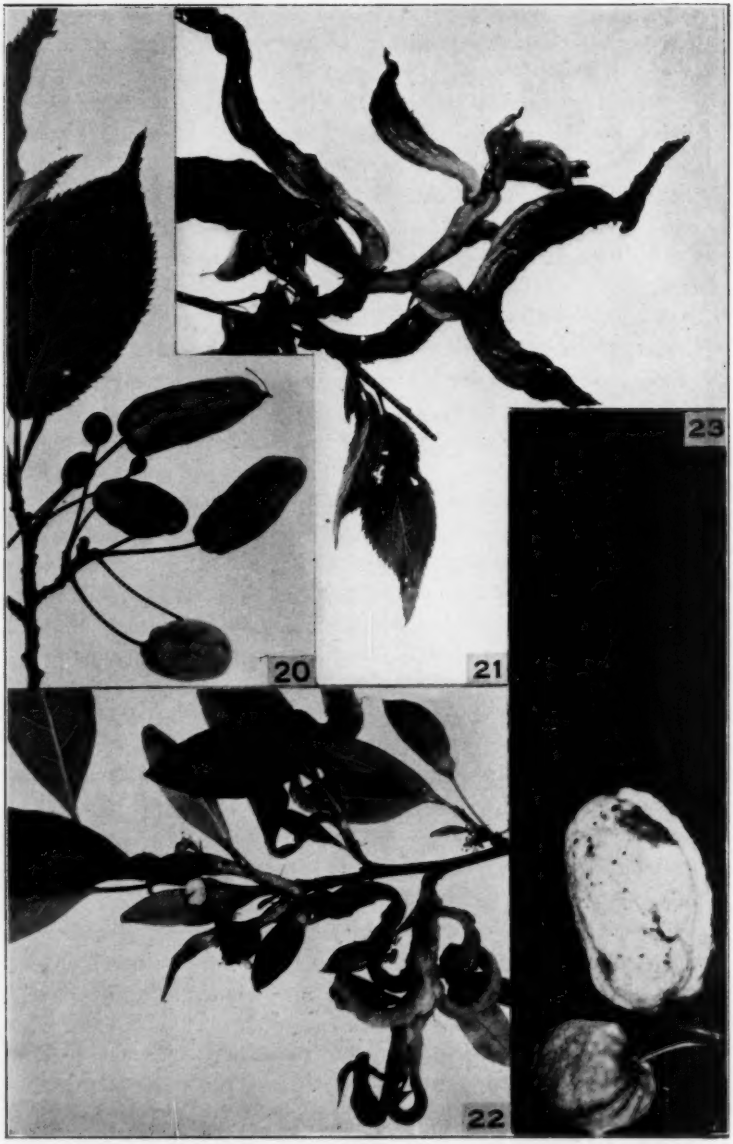
Numerous isolates have been obtained from diseased flowers and leaves, and all found alike in their response to extremes in temperature and in their ability to maintain life at high temperatures.

The rate of growth at 0° C. and 3° C. is not so rapid as for some other species of *Taphrina*. At 27° C. or higher, no growth takes place, whereas, isolates of twenty-one other species of *Taphrina* tested show growth. At 30° C. the isolates remain viable between 3 and 6 days and at 27° C. between 25 and 30 days. All other species of *Taphrina* tested maintain life longer than 30 days at 27° C., some for 6 months.

On the basis of morphology and cultural characteristics the writer feels that only one species is responsible for the disease of *P. virginiana*. Since *Exoascus confusus* was described by Atkinson (**1**) in 1894 and *E. unilateralis* by Peck (**8**) in 1898, the name applied by the former has priority. Giesenhagen (**4**) in 1895 placed Atkinson's species in the genus *Taphrina*, calling it *Taphrina confusa* (Atk.) Gies.

Though there exists certain morphologic similarities between *T. confusa* and *T. Farlowii*, the asci and basal cells of the former are on the average longer than those of the latter. On the basis of cultural characteristics, these two species are quite distinct.

Taphrina Farlowii is chiefly southern in its range and occurs commonly in the states south of Delaware. An intensive search for this fungus in New York has been unsuccessful, even though *P. serotina*, its host, is a common plant. *Taphrina confusa* on



FIGS. 20. 21, *Taphrina communis;* 22, *T. flavorubra;* 23, *T. communis.*

the other hand, has been found only in the northern states. A collection made by John Dearness in Canada and issued in Seymour and Earle, Econ. Fungi *467*, as *E. Farlowii* on the ovaries of *P. serotina*, is *T. confusa* on the ovaries of *P. virginiana*.

The evidence presented convinces the writer that *T. Farlowii* and *T. confusa* are valid and distinct species.

SPECIMENS EXAMINED: Material from Canada, Michigan, and New York has been studied. The writer's herbarium contains 30 collections made by him near Ithaca, New York.

TAPHRINA COMMUNIS (Sad.) Gies.: In the vicinity of Ithaca, New York, *Taphrina communis* (Sad.) Gies. commonly causes "pockets" of *Prunus nigra* Ait. (FIG. 23) and *P. americana* Marsh. (FIG. 20). The size of the asci and basal cells (FIG. 11, 12) from diseased fruits of both hosts are as given by Sadebeck (**1893**). The basal cells, however, are slightly wider than originally described.

For the past two years the writer has collected infected shoots and fruits of *P. americana* in several plum thickets (FIG. 20, 21). Diseased fruits occurred chiefly on the larger shrubs and deformed shoots on the smaller. Occasionally tender shoots of the mature plants also were diseased.

Atkinson (**1894**) believed that the fungus on the leaves of *P. americana* differs from *T. communis* on the fruits and he named it *Exoascus decipiens*. He stated that the asci are 20–40 $\mu \times 7$–10 μ, and that the basal cells are 6–13 μ long $\times$ 7–12 μ wide. He wrote, "the young shoot is somewhat enlarged, though there are developed no asci on any of the shoots which I have seen."

An examination of the type specimen, collected at Danby, New York, near Ithaca, reveals that the asci and basal cells are as Atkinson described them. Asci are found only on the leaves and not on the shoots or petioles.

In several collections made by the author, asci were found on stems, petiole, and leaf-blade (FIG. 13). The asci from the stem and base of the petiole are 37–49 $\mu \times 7$–11 μ, and the basal cells are 16–23 $\mu \times 3.5$–8 μ. These dimensions approximate those of asci and basal cells from fruits. Asci from the base of infected leaf-blades are 27–41 $\mu \times 7.7$–11 μ and the basal cells 11–17 $\mu \times 5$–10 μ. Sections of leaves near the extreme limits of the my-

celial invasion, disclose smaller asci with wider and shorter basal cells than these same structures from stems, petioles, and fruits. The asci are 23–35 $\mu \times 7$–9 μ, and the basal cells are 7–13 $\mu \times 7$–12 μ. These measurements correspond with those given by Atkinson for *E. decipiens*. It is evident that asci and basal cells become smaller in size from the stem toward the outer extremities of infection in the leaf-blade.

Since *E. decipiens* was based on asci and basal cells from the leaf-blade, it is understandable that Atkinson should believe it to be different from *T. communis* on the fruits. However, in the light of the evidence presented, the writer feels that only one species is the cause of the disease of *P. americana*.

Isolates obtained from diseased fruits and shoots are alike as to color, consistency, and temperature relationships.

On the basis of the various facts and observations, *E. decipiens* is relegated to synonymy in favor of *T. communis*. The concept of *T. communis* must be expanded therefore to include the disease of shoots and leaves of *P. americana*.

SPECIMENS EXAMINED: Material on *P. nigra* from New York and on *P. americana* from Kansas, Montana, Nebraska, New York, and North Carolina has been examined. The writer's herbarium contains 10 collections made by him near Ithaca, New York.

Taphrina flavorubra sp. nov.

Hymenio subcuticulari; mycelio interiore in spatiis intercellulariis abundante; ascis cylindraceis vel clavatis, in apice rotundatis, 20–40 μ longis $\times$ 6–10 μ crassis; cellula basalari ad basim rotundata vel acuta, 8–16 μ alta $\times$ 4–9 μ crassa; sporidiis octonis vel multis, ellipsoides, 3–6 $\times$ 2–4 μ.

DISTRIBUTION: Causing a hypertrophy of fruits, shoots, and leaves of *Prunus Susquehanae* in the United States.

TYPE: In the herbarium of the Department of Plant Pathology, Cornell University, No. *26425*.

SPECIMENS EXAMINED: The writer has made 3 collections near Ithaca, New York, and has examined 7 other collections made in the same place in past years.

Atkinson (**2**) among other workers (**4, 7, 14**) believed *Taphrina communis* (Sad.) Gies. to be the cause of "pockets" of *Prunus*

Susquehanae Willd., although he stated that he had never seen the asci. Patterson (**7**), likewise failed to examine the asci on this host.

This plant grows abundantly in a small, confined locality near Ithaca, New York. In 1936 and 1938 diseased fruits were found, and in 1937 the disease was severe on both fruits and shoots. To the author's knowledge, hypertrophy of the shoots (FIG. 22) has never been reported in the literature.

Microscopic examinations of asci and basal cells from fruits and shoots disclosed only one species as the cause (FIG. 9). The asci and basal cells compared with those from the fruits of *P. americana* and *P. nigra* are decidedly shorter.

Asci from near the outer extremes of the mycelial invasion into the leaf were found to be shorter and the basal cells wider than those same structures from the fruit or stem. A similar observation was made in the case of *T. communis* on the shoots of *P. americana*.

Prunus Susquehanae is a member of the "cherry" division of *Prunus* and not of the "plum." Since nearly all species of *Taphrina* are specialized in their host relationships, it would be natural to expect that a species affecting plums would be unlikely to cause a disease of cherry.

The "pockets" produced are never as large in proportion as are diseased fruits of *P. nigra* and *P. americana*. The fruits become elongated and hollow, and often both ends taper, especially the distal one (FIG. 22). Ridges and furrows in the plane of the long axis are often present, and the infected fruits are bright-red, or yellowish-red. The shoots likewise when invaded by mycelium become yellowish-red. In contrast, fruits and shoots of *P. americana* affected by *T. communis* are white or yellowish.

Isolates obtained from diseased shoots and fruits were identical in every respect. When compared with isolates of *T. communis*, those from *P. Susquehanae* were found lighter in color, but all other characters tested were the same.

On the basis of the size of the asci and basal cells, the color and other symptoms of diseased tissues, and the host relationship, the writer believes that a species differing from *T. communis* is responsible for the disease of *P. Susquehanae*. He proposes to

call the fungus *Taphrina flavorubra,* a name referring to the yellowish-red color of the infected host tissues.

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EXPLANATION OF FIGURES

FIG. 1, asci of *Taphrina rugosa* from bract of fertile catkin of *Alnus rugosa* collected in Georgia; 2, asci of *T. amentorum* from bract of fertile catkin of *A. oregona* collected in Alaska; 3, asci of *T. Robinsoniana* from bract of fertile catkin of *A. incana;* 4, asci of *T. Robinsoniana* from diseased shoot of *A. incana;* 5, *T. occidentalis,* the two asci at the left from bract of fertile catkin of *A. oregona,* the two asci at the right from *A. rhombifolia;* 6, asci of *T. media* from leaf of *A. crispa* var. *mollis;* 7, asci of *T. Atkinsonii* from fruit of *Prunus Cāpuli;* 8, *T. confusa,* the two asci at the left from fruit of *P. virginiana,* the two at the right from leaf; 9, *T.*

flavorubra, the two asci at the left from shoot of *P. Susquehanae*, the two at the right from fruit; 10, *T. Farlowii*, the two asci at the left from leaf of *P. serotina*, the two at the right from fruit; 11, asci of *T. communis* from fruit of *P. nigra;* 12, asci of *T. communis* from fruit of *P. americana;* 13, *T. communis*, ascus at the left from shoot of *P. americana*, the two asci at the right from near the base of an infected leaf. All drawings × 893.

FIG. 14, hypertrophied bracts of *Alnus rugosa* caused by *T. rugosa*, nat. size; 15, hypertrophied bracts of *A. incana* caused by *T. Robinsoniana*, nat. size; 16, diseased fruits and leaves of *P. serotina* caused by *T. Farlowii*, nat. size; 17, fruits and flower parts of *P. Capuli* deformed by *T. Atkinsonii*, nat. size; 18, hypertrophy of ovaries, petals, stamens, pedicels, and peduncle of *P. virginiana* caused by *T. confusa*, × 1½; 19, lesions on leaves of *P. virginiana* caused by *T. confusa*, nat. size; 20, diseased fruits of *P. americana* caused by *T. communis*, reduced 1/12; 21, deformed shoots of *P. americana* caused by *T. communis*, reduced 1/12; 22, hypertrophied shoot, leaves, and fruits of *P. Susquehanae* caused by *T. flavorubra*, reduced 1/10; 23, "pockets" of *P. nigra* caused by *T. communis*, reduced ¼.

THE DERMATOPHYTE MICROSPORUM LANOSUM [1]

ELEANOR SILVER DOWDING & HAROLD ORR

(WITH 29 FIGURES)

1. CLINICAL OBSERVATIONS

Microsporum lanosum is capable of infecting the hair and the glabrous skin of animals and of human beings. In man it may produce ringworm of the scalp, ringworm of the body, and more rarely ringworm of the beard.

The chief fungi causing scalp ringworm are two, *Microsporum Audouini* and *M. lanosum*. *M. Audouini* produces non-inflammatory lesions which must be treated by epilation. *M. lanosum* commonly produces inflammatory lesions which may be cured by local applications of fungicides. However, in our survey of the dermatophytes of Alberta we have repeatedly isolated *Microsporum lanosum* from non-inflammatory scalp lesions. Therefore a mycological as well as a clinical study of the dermatophyte is necessary for diagnosis.

Cleveland, in British Columbia (**2**), cured 26 non-inflammatory tinea capitis cases (which he provisionally classified from their appearance, without cultural studies, as of the " human " type—*i.e. M. Audouini*) by local therapy alone. Since publishing his results, Dr. Cleveland very kindly sent us infected hairs from six of these patients with dry scaly lesions and one with suppurating lesions, all of which he had cured by local treatment. Seven cultures were obtained from this material and upon mycological examination they all proved to be *Microsporum lanosum*. The apparently anomalous reaction to Dr. Cleveland's treatment was therefore explained.

The non-inflammatory type of ringworm due to *M. lanosum* is in fact clinically indistinguishable from that due to *M. Audouini*.

[1] Contribution from the Provincial Laboratory, University of Alberta, Canada.

In culture, however, *M. lanosum* can be readily recognized by its more vigorous growth and more numerous spores.

2. MATERIAL AND METHODS

The species of dermatophytes are distinguished one from another in the saprophytic stage of their life history. For successful identification they must be grown on a medium which produces the minimum variation. Sabouraud's medium, which has been the standard substance for culture, produces variations in the fungus in response to slight unavoidable differences in the peptone constituent.[2]

Conant (**3**) testing a number of species of *Microsporum* on different media, obtained the least variation and the most abundant sporulation on rice. This medium has been used in the present investigation. Erlenmeyer flasks were filled with one volume of polished rice and three volumes of water, and sterilized by heating on three consecutive days without pressure. The flasks were then inoculated with infected hair or skin and kept at room temperature.

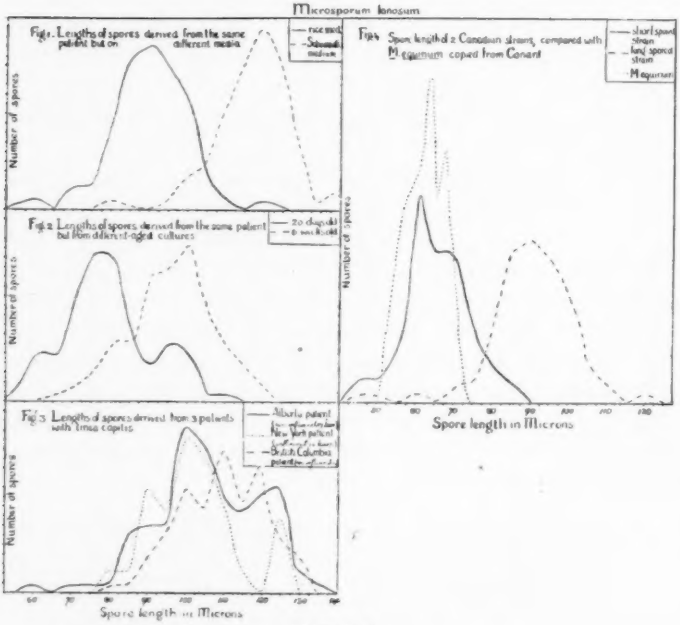
It is important to emphasize that the character of the mycelium of a dermatophyte varies with the composition of the medium and the age of the culture. This is illustrated by the following observations:

(1) Two cultures were used, both derived from the same patient, and of the same age, but one was grown upon rice and the other upon Sabouraud's medium. The lengths of one hundred macroconidia from each culture were measured and frequency graphs were constructed as shown in figure 1. The mean length of spores formed on rice is 90 μ (with a standard deviation of 10 μ), and that of spores on Sabouraud's medium is 119 μ (with a standard deviation of 10 μ)—a difference of 29 μ.

(2) Two cultures were used, both derived from the same patient, and grown on Sabouraud's medium, but one had been growing for 20 days and the other for 6 weeks. The lengths of one

[2] Plaut, and later Davidson and Gregory (**7**) have obtained saprophytic spore forms of several species by allowing them to grow out into the air from the original infected human tissue which is planted in damp chambers of determined humidity. Although this method dispenses with a variable medium, the "in situ" cultures are too small for some purposes.

hundred spores from each cultures were measured and the resulting graphs are shown in figure 2. It may be seen that the mean length of spores of the old culture is 79 μ (with a standard deviation of 12 μ), while that of spores of the young culture is 95 μ (with a standard deviation of 10 μ)—a difference of 16 μ.


Microsporum lanosum
Fig 1. Lengths of spores derived from the same patient but on different media
rice and Sabouraud medium
Fig 4 Spore length of a Canadian strain, compared with M. equinum copied from Conant
short spored strain
long spored strain
M. equinum
Number of spores
Fig 2 Lengths of spores derived from the same patient but from different aged cultures
20 days old
6 weeks old
Fig 3 Lengths of spores derived from 3 patients with Tinea capitis
Alberta patient
New York patient
British Columbia patient
Spore length in Microns

FIGS. 1–4.

Conant (**5**) in his paper on the taxonomy of the genus *Microsporum* uses the length of the macroconidium as a basis of diagnosis of species. Thus the difference between the mean spore length of two well-established species, *M. fulvum* and *M. lanosum,* is 30 μ. Yet the above experiments show that spores from the same species will vary in length as much as 29 μ under different conditions.

(3) When *Microsporum lanosum* is grown on rice at room temperature the culture passes through the following progressive changes:

At first the aerial mycelium is white and coarsely downy, producing few microconidia and no macroconidia. During the second week it becomes "pinkish-buff" and granular. This change is due to the production and shedding of large numbers of macroconidia. By the 20th day, tufts of fine, white downy "pleomorphic" growth appear here and there over the surface, subsequently spreading and covering the whole culture. Under dry conditions the white growth is sterile or almost sterile. With more moisture it produces large numbers of microconidia.

On Sabouraud's medium the progressive changes are slower, the maximum production of macroconidia being in the third week.

These three observations should make it clear that it is necessary to use identical conditions for comparable results. In the present investigation cultures were grown on rice (unless otherwise stated) at room temperature for two weeks, at which time the macroconidia production was at its peak.

Twelve strains of *Microsporum lanosum* were isolated from twelve patients, most of whom were residing in Alberta or British Columbia, and who were suffering from different types of ringworm.

The more important taxonomic characters of *Microsporum lanosum* are described by Conant (**5**) as follows:

"Colonies matted or cottony, white to 'pinkish buff' becoming powdery, coloring rice yellow; macroconidia 54–94 × 14–22 μ, 2–10 septate, fusoid, warty or spinose, hyaline or light yellow, outer walls of median cells conspicuously thickened."

The spores germinate readily within 24 hours on corn-meal agar or rice. The microconidia swell and send out one or more germ-tubes from any part of the cell wall. The macroconidia send out germ-tubes from their two ends (FIG. 5). The extreme thickness of the lateral wall in this species probably makes lateral germination difficult. Only one spore was found among a hundred or so, in which a germ-tube broke through the lateral wall. On the other hand, when the thin-walled macroconidia of *Microsporum fulvum* germinate, the germ-tubes break out from every side of the spore (FIG. 6).

3. TWO CANADIAN STRAINS[3]

In order to verify the provisional classification of the cultures which by their gross characters resembled *Microsporum lanosum*, one hundred spores from each culture were measured.

Widths. The widths of the macroconidia are very variable. Figures 7 and 8 show the difference in widths of spores derived from different patients. This difference is quite considerable, although the photographs are random ones with no attempt to select different sizes.

For three isolates, distinguished as A, B and C, the means and standard deviations of the widths are shown in the accompanying table:

	A	B	C
Mean.....	21.19 μ	16.37 μ	18.87 μ
S.D.....	2.17 μ	2.58 μ	2.05 μ

The difference between the means of A and B is 4.8 μ, the standard deviation of the difference is 3.4 μ, and therefore there is a probability of about 0.08 of obtaining as great a difference as this in samples of 100 by chance alone. The observed difference cannot therefore be regarded as significant, and we are not justified in assuming, as the photographs might suggest, that we are dealing with narrow-spored and wider-spored strains.

Lengths. Spore lengths, based on the measurements of one hundred spores did not vary much in most of the cultures. Figure 3 shows graphs of spore-lengths from three such cultures growing on Sabouraud's medium.[4]

However, when measurements were made from seven isolates,

[3] For the statistical computations of the spore measurements, the writers are indebted to Professor E. S. Keeping of the University of Alberta.

[4] It can be seen from figure 3 that most of the graphs have three peaks. These may possibly be due to personal errors in measurement. On the other hand each culture was obtained from a single infected hair but not from a single uninucleated spore, so that there are grounds for supposing that the original lesions were mixed infections of several strains with different spore lengths. This would produce a multi-modal graph characteristic of a mixed population.

it was found that while six resembled each other closely in spore length, one had much shorter spores. Comparison of the short-spored strain (D) with a representative long-spored culture (E) based on measurements of 100 spores each, is shown in the acompanying table.

	D	E
Mean.....	64.6 μ	90.1 μ
S.D.....	9.5 μ	9.9 μ

The probability that this difference in length is due purely to sampling fluctuations is only 0.03, so that we are probably justified in speaking of D and E as distinct strains.

Figure 4 shows that the maximum length of spores of the long-spored strain, is 120 μ (150 μ in Sabouraud's medium). Conant's maximum length of spores of *M. lanosum* is 94 μ. Dr. Conant has examined a number of the Canadian long-spored cultures and agrees that they are *Microsporum lanosum* although the spores are longer than any he has described. The same figure shows that the maximum length of spores of the short-spored strain is 85 μ.

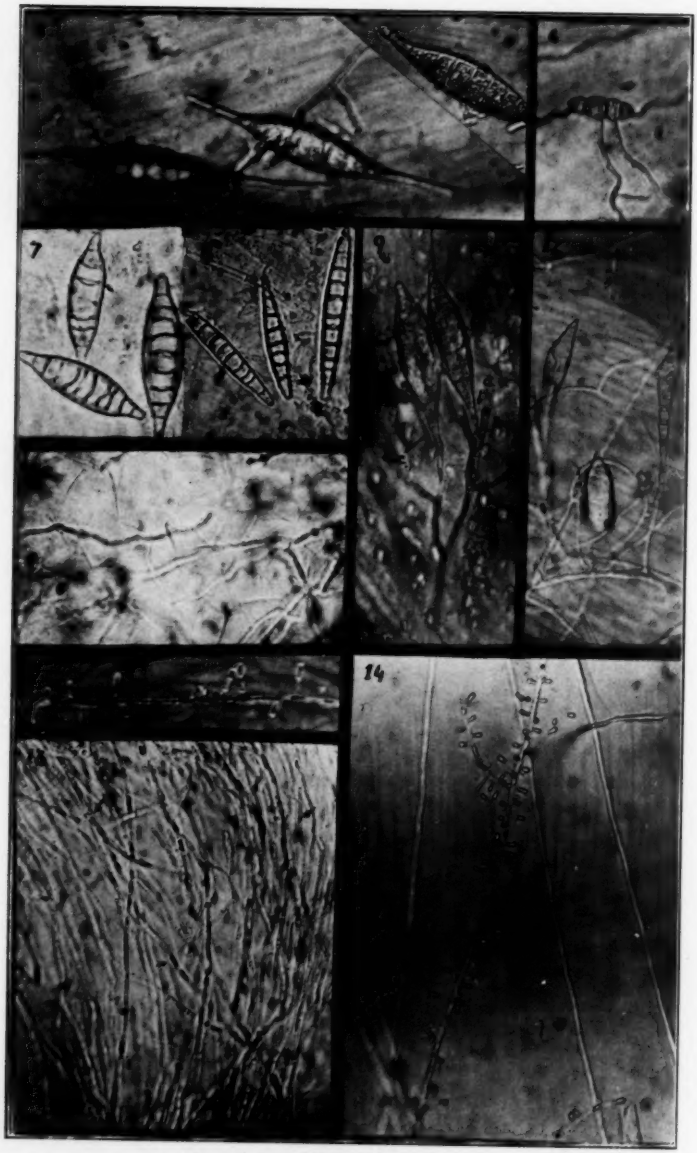
The spores from the two strains are illustrated in figure 19 and 20. The spores of the short-spored strain are less septate (this does not appear in figure 20), less torrulose, and are borne on rather stouter conidiophores than those of the long-spored strain. Dr. Emmons examined the short-spored strain and agrees that it is also *M. lanosum*.

No correlation could be discovered between the strain of *Microsporum lanosum* and the clinical type of ringworm which it caused, as is shown from the following observations:

(1) A long-spored strain and a short-spored strain were isolated from 2 different patients. Both of these patients possessed similar dry scaly lesions on the scalp.

(2) Cultures derived from dry scaly lesions of the scalp and cultures derived from inflammatory lesions showed no significant difference in spore length as is shown in the table.

The difference of the means for these cultures is so small compared with the standard deviations that the differences are clearly not significant.



FIGS. 5–14. *Microsporum lanosum.*

Type of Lesion	Scaly	Scaly	Inflammatory
Mean	106 μ	110 μ	102 μ
S.D.	13.7 μ	11.3 μ	11.9 μ
Number	127	100	100

Figure 4 shows that the spore lengths of *Microsporum lanosum* may vary from 45 to 120 μ, a range of 75 μ. On this chart we have superimposed Conant's graph of spore lengths in *M. equinum* (**4**). It shows that there is actually more difference in spore lengths between the two strains of *M. lanosum* than there is between *M. lanosum* and *M. equinum*. *M. simiae* Conant is equally close to *M. lanosum* in spore length.

We have not had the opportunity of examining the species *M. equinum* or *M. simiae*, but if their validity depends principally on spore length we suggest they should be included in *M. lanosum*.

Conant separates *M. simiae* from other *Microspora* by an additional feature—the possession of an obconical cell of dehiscence at the base of the spore. Nevertheless such abscission cells occur in *M. lanosum* and in *M. fulvum* and will be described later in this paper.

4. THE MICROCONIDIA

The microconidia of *Microsporum lanosum* are found in cultures a few days after inoculation, but they are most prolific on older mycelia. They are produced on aerial conidiophores, are sessile or with short necks, and measure 3–5 $\times$ 1–5 μ.

The microconidium has been studied in detail in *Trichophyton gypseum* by Emmons (**9**). He observes that it arises from the conidiophore as a conical bud. He finds that the mature spore may itself bud to form a second spore, continuing in this way until a short chain of spores is formed.[5] He has observed that when the microconidium is shed it retains a collar of wall tissue which marks the place of attachment to the conidiophore, and that a scar marks the place on the conidiophore where the spore broke away.

[5] The writer has watched a similar formation of chains of spores by budding in *T. rubrum*.

The microconidia of *Microsporum lanosum* differ in a number of respects from those of *Trichophyton gypseum:* (1) The conidiophore is unbranched, so that the spores are not "en grappes"; (2) The spores are borne singly, not in chains; (3) The free microconidia have never been observed to possess collars, and no scars have been seen on the conidiophores.

In Van-Tieghem-cell cultures, the conidiophores and conidia that adhere to the cover-slip may be examined under high magnification without disturbing them. Many of the conidiophores are then found to be dissolved for all or part of their length, leaving the conidia free (FIG. 14).

The conidium is a more resistant structure than the conidiophore. The wall is thickened, particularly at the apex and base, and frequently possesses a longitudinal ridge of thickening (FIG. 11, 29). In iodine and sulphuric acid the conidiophore quickly disappears but the conidia persist.

Certain cells of the conidiophores may be found which are evidently of the same resistant material as the spores, for they persist like the spores and can be distinguished from them only by their barrel-like shape.

Mason (**11**), annotating the fungi received at the Imperial Mycological Institute, emphasizes that descriptions of spores should include their dispersal mechanism, *i.e.* whether they are "dry" spores adapted for distribution by air or "slime" spores adapted for distribution by water or another such agent.

The microconidia of *Microsporum lanosum* are produced most abundantly in wet cultures. They collect in the moisture exuded by the aerial mycelium and a smear of this liquid on a glass slide contains vast quantities of them. They are clearly "slime" spores.

"Slime" microconidia have been illustrated by the writer in *M. Audouini* (**6**), and Davidson and Gregory have illustrated them in *Achorion Schoenleinii* (**7**). On the other hand the microconidia of *Trichophyton gypseum* are normally "dry" spores, although under certain conditions, as we have illustrated (**8**), they are "slime" spores.

5. THE MACROCONIDIA

The mature macroconidium possesses at its base an empty cell which ruptures to set the spore free. It is illustrated in figures 9, 18 and 19. Different ages of macroconidia were studied to discover the way in which the cell is formed.

It was found that the macroconidium begins to form on 7-day-old cultures as a club-shaped swelling at the end of an aerial hypha. A septum then appears a little distance from the base of the swelling (FIG. 15). The outer wall now becomes irregularly tuberculate from the tip of the hypha to a short distance from the septum (FIG. 16, 17). About 24 hours later additional septa appear which are deposited on the outer wall and grow inwards, ceasing growth so that an annular perforation is left between adjacent cells (FIG. 18). At this time the outer wall thickens. The lowermost of the later-formed septa, together with the first formed septum, demark a cell with an average length of 10 μ, with no tuberculate markings and no thickening on the wall. The contents of this cell are withdrawn into the two neighboring cells, and, being then empty, its two transverse septa bulge inwards. This cell is the abscission cell (FIG. 18). When the spore is shed the abscission cell ruptures in such a way as to leave usually a collar projecting from the base of the spore and also a collar surmounting the conidiophore (FIG. 21, 22).

Since the macroconidia are set free by the rupture of a special cell, and since they collect as a powdery deposit on the surface of the culture, they are clearly " dry " spores adapted for dispersal by air.

We have observed abscission cells at the base of the macroconidia of *Microsporum fulvum* and of *Trichophyton gypseum*. It is probable that the macroconidia of dermatophytes are regularly " dry " spores.

6. THE SECONDARY MYCELIUM

When rice cultures of *Microsporum lanosum* are about 20 days old, white tufts of mycelium appear sporadically over the surface. The tufts enlarge and meet one another until the whole sporulating surface is overlain by a white sheet-like covering. This transformation of a dermatophyte is usually known as " pleomorphism "

and the white growth as "pleomorphic" mycelium, but since (as will be shown later) this mycelium is not always completely pleomorphic in Sabouraud's sense, it will be described here as "secondary mycelium."

The secondary mycelium of *Microsporum lanosum* usually possesses the following characters:

(1) The hyphae are, on the whole, narrow, the average width being 1.25 μ. (The width of the hyphae of the primary mycelium will range from 7.5 in extremely vigorous hyphae to 1.9 μ, the average width being 2.5 μ.)

(2) The culture may produce a few macroconidia, but most of these are not normal and do not produce septa or become thick-walled (FIG. 12). They frequently grow out from their apex or the base while still attached to the conidiophore. Often they are merely pear-shaped terminal swellings of the hyphae.

(3) Under moist conditions the culture will produce large numbers of microconidia (FIG. 14). Under dry conditions the culture is usually sterile.

(4) The inner surfaces of the cell walls of drier cultures possess characteristic thickenings sporadically distributed along the hypha. They take the form of thin plates or rings of irregular outline (FIG. 27, 28) which show clearly when the preparation is mounted in alcohol or lactic acid. Two microchemical tests for chitin were made upon the wall thickenings of secondary mycelia.

(*a*) Treated with iodine in potassium iodide and then with concentrated sulphuric acid, the unthickened portions of the wall are coloured blue and quickly dissolve. The thickened portions turn red and retain their shape for some time.

(*b*) When treated for a short time with fresh iodine in potassium iodide and then with concentrated chloride of zinc and washed in water, the unthickened portions are unaffected but the thickenings are coloured blue green.

Since the characteristic colour reaction for chitin in test (*a*) is brown, and in test (*b*) is violet, the thickenings must be some other form of cellulose.

(5) The secondary mycelium readily fragments into short lengths when it is mounted in water. This character is probably due to the uneven thickness of the cell walls.

Sabouraud has described dermatophytes as "pleomorphic" when they become overgrown by a white "duvet" of mycelium which produces no spores and which upon transfer to fresh medium (or even after passage through an experimental animal) remains sterile and will not revert to the original condition. Langeron and Milochevitch (**10**) also use this definition.

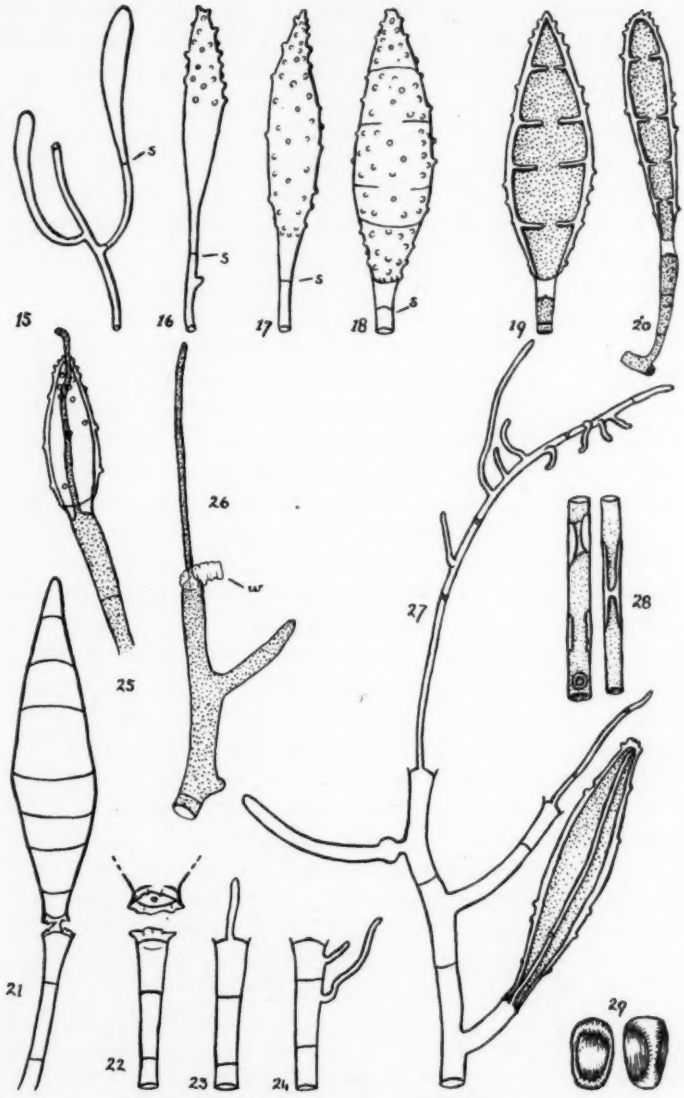
Transfers were made of the secondary mycelium of *Microsporum lanosum* to fresh medium to determine whether its condition was reversible or not.[6]

To make a transfer a small portion of the secondary mycelium was stripped from the surface of the culture and mounted in sterile water and examined microscopically to insure that there were no macroconidia carried over from beneath. The inoculum was then transferred to fresh rice. In this manner inoculations were made from secondary mycelia of cultures growing at room temperature for the following periods: 1 month; 2 months; 3 months; 5 months; 1 year. It was found that inocula three months old or less developed within two weeks into a cream-coloured mycelium with masses of macroconidia indistinguishable from cultures derived from the original infected hair or from a macroconidium. On the other hand transfers from inocula 5 months or a year old grew out into a white mycelium which usually produced microconidia but only occasionally macroconidia. In general they retain the characters of a secondary mycelium, but since they still produce spores, they could not be described as "pleomorphic" in Sabouraud's sense of the word.

An attempt was then made to determine in what manner the secondary mycelium originated from the primary mycelium.

Buller (**1**), working with *Pyronema confluens* and other fungi, found that after the experimental killing or natural death of a cell in a hypha, a plug immediately closes the pore of the septum of the living cell adjoining the dead cell and the septum bulges

[6] A two-months-old rice culture of *Microsporum lanosum* was sterilized in an autoclave. The underlying rice was then exposed by cutting away the mycelium, and inoculated with a portion of the secondary growth of a two-months-old culture. Within two weeks the inoculum had spread over the rice and become cream-coloured with masses of macroconidia, *i.e.*, the mycelium reverted to the primary condition. It was concluded that the secondary growth was not brought about by the staling of the medium.



FIGS. 15–29. *Microsporum lanosum.*

towards the dead cell. An intrahyphal hypha then grows out from the septum of the adjacent living cell into the dead cell.

In *Microsporum lanosum* when a cell of a hypha is wounded experimentally or when it dies naturally, a hypha grows out from the adjacent living cell as has been described by Buller. Since the new hypha does not necessarily grow within a dead cell it will here be termed a "secondary" rather than an "intrahyphal" hypha. A secondary hypha grows out, not from the whole septum but from the perforation, or from a small part of the wall, of the "primary" hypha, and it is always narrower than the primary hypha.

Figure 26 shows a hypha of *Microsporum lanosum* growing in a hanging drop of Sabouraud's medium in a Van Tieghem cell. It had been killed at the end by touching it with a hot needle and had died back to the septum which had become plugged. Twelve hours after wounding a secondary hypha has grown out from the septum and attained the length shown in the figure.

Figure 25 shows an aborted macroconidium from an old rice culture. The spore died and became empty without the formation of any septa except the basal septum of the abscission cell. A secondary hypha has grown out from this basal septum through the spore and out from its apex. Conant (**5**) illustrates a similar "germination" of the macroconidium.

The following observation suggests that the secondary mycelium of *Microsporum lanosum* takes its origin from secondary hyphae, usually growing out from the base of the abscission cell. Smallest possible masses of white secondary "duvet" from 20-day-old cultures, together with the underlying mycelium, were removed from the culture with a needle and examined microscopically. It was found that most of the spores had been shed. The bare conidiophores could be distinguished from other hyphae because they were wider at the tip (FIG. 9*c*), and frequently possessed a terminal collar left from the ruptured abscission cell. It was found that a great many of these conidiophores were growing out again. A narrow hypha pushed out through the plugged perforation of each bulging terminal septum (FIG. 23). Less frequently, hyphae grew out from other parts of the conidiophore (FIG. 24).

The secondary hyphae are narrow, measuring 1.25 μ, frequently possess irregular thickenings (FIG. 27, 28), and have never been observed to produce spores.

Attempts were then made to induce the formation of the secondary mycelium experimentally.

(1) The aerial mycelium of two 6-day-old test-tube cultures which had not yet produced macroconidia was killed by drawing a hot L shaped platinum needle repeatedly over its surface. Within the next day or two, aerial hyphae had grown out again. Two weeks after wounding, the culture had produced no macroconidia, nor did it produce any during the next month. On the other hand, the two-weeks-old control culture which had not been wounded was covered with macroconidia.

(2) A six-day-old flask culture which had not yet produced macroconidia was wounded as described above. In the next two days the mycelium spread out over the untenanted rice at the periphery of the flask, and hyphae grew out again into the air from the wounded mycelium in the centre of the flask. After two weeks the mycelium at the periphery was in the primary condition. It was cream-coloured with a loose cottony texture and produced abundant macroconidia. The wounded central part of the culture had grown out into a white, densely downy mound of secondary mycelium which bore microconidia but no macroconidia. These two experiments show that the secondary mycelium, which naturally appears after the macroconidia are shed, may be produced experimentally before the macroconidia have formed, by wounding the primary mycelium.

SUMMARY

1. *Microsporum lanosum* may produce inflammatory or non-inflammatory lesions of the scalp. When it produces non-inflammatory lesions it may be clinically indistinguishable from *M. Audouini*. Since the *M. lanosum* and the *M. Audouini* ringworms yield differently to treatment, a mycological study of the dermatophyte is frequently of the utmost importance.

2. Two strains of *M. lanosum* have been isolated in Canada, one with short spores and one with long spores. The two strains produce the same clinical type of ringworm.

3. The microconidia and the macroconidia, both of which are produced upon artificial media, possess different dispersal mechanisms.

4. The microconidia are set free by the dissolution of the conidiophores and collect in slimy masses.

5. The macroconidia are set free by the rupture of certain cells termed abscission cells, and they collect as a powdery deposit over the surface of the culture.

6. The powdery spore deposit becomes overgrown by a close-textured white down, termed "secondary mycelium" which is composed of narrow, peculiarly thickened, almost sterile hyphae.

7. The secondary mycelium when it is still young may be transformed to the original primary condition by transfer to fresh medium but when it is older it remains in its secondary condition even after transfer.

8. The secondary mycelium usually originates from the base of the abscission cell after the spores are shed.

9. The secondary mycelium may be produced experimentally before the spores are produced, by wounding the primary mycelium.

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EXPLANATION OF FIGURES

FIG. 1–4. *Microsporum lanosum.* Frequency graphs of lengths of macroconidia—each graph based on one hundred measurements.

FIG. 5–14. *Microsporum lanosum* (except Fig. 6). Magnification, 300 (except Fig. 11, which is 600). 5, macroconidia sown in a hanging-drop of corn-meal agar 24 hours ago, showing germ-tubes grown out from each end of the spores. 6, macroconidia of *M. fulvum* under similar conditions with germ-tubes growing from ends and side of spore. 7, macroconidia from culture derived from patient "F." 8, macroconidia from culture derived from patient "C." 9, macroconidia on 6-day-old rice culture; left, young spore without septa and with wall markings extending from the apex to the top of the abscission cell (*a.c.*) which is not yet cut off; centre, older spore with septa and with the abscission cell (*a.c.*) cut off; right, conidiophore (*c*) after the spore has been dispersed. 10, skin from lesion on hand, in potassium hydroxide to show mycelium. 12, abortive macroconidia on 28-day-old rice culture. 13, pleomorphic mycelium in lactic acid from culture left for one year at room temperature, to show irregular wall thickenings. (The arrows point to some of them.) 11 and 14, fugaceous hyphae bearing microconidia in 6-day-old Van-Tieghem-cell rice culture.

FIG. 15–29. *Microsporum lanosum,* magnification 400, except 28 and 29 which are larger. 15–18, stages in the development of the macroconidium. 15, formation of first septum, *s.* 16 and 17, development of wall thickenings. 18, appearance of other septa and delimitation of abscission cell. 19, macroconidium of long-spored strain. 20, of short-spored strain. 21 and 22, rupture of abscission cell and liberation of macroconidium. 23, 24 and 25, secondary growth from conidiophore (25, growth through dead spore). 26, secondary growth of hypha after wounding at *w* with hot needle. 27, secondary growth of three conidiophores. 28, types of wall-thickening in pleomorphic hyphae. 29, microconidia showing wall-thickening.

PHOTOGRAPHS AND DESCRIPTIONS OF CUP-FUNGI—XXXI. MOLLISIELLA

FRED J. SEAVER

(WITH 1 FIGURE)

In January, 1938, the writer received from Miss Lenore Aldingèr, of Madison, Wisconsin, a branch of avocado from Florida infected with *Tryblidiella,* on which occurred a minute discomycetous fungus, for study and determination. In April of the same year similar specimens were received from Dr. R. K. Voorhees, of Florida, under the name of *Cenangium Ravenelii* (Berk. & Curt.) Sacc. On checking up these two specimens it was found that *Cenangium Ravenelii* was regarded by Rehm as a synonym of *Mollisiella ilicincola* (Berk. & Br.) Massee. In the meantime the specimen sent from Wisconsin was determined by Mrs. Stifler, of Chicago, as *Lachnellula hysterigena* (Berk. & Br.) Sacc. This was also regarded by Rehm as a synonym of *Mollisiella ilicincola.* Massee (Jour. Linn. Soc. **31**: 522) also treated it as a synonym.

The name *Mollisiella* was first used by Phillips in his British Discomycetes as a subgenus of *Mollisia.* Later George Massee, in 1895, took up the name and used it for the globose spored species only. The genus was based on *Peziza ilicincola* Berk. & Br. Since the writer had not before encountered any American material of this genus, or species, he was especially glad to have the two collections from Florida. Since this genus and species is very unusual this opportunity is taken to describe and illustrate the fungus so that it may be recognized by later collectors. Following is the diagnoses of the genus and species:

Mollisiella (Phill.) Massee, British Fungus-Fl. **4**: 221. 1895

Mollisia § *Mollisiella* Phill. British Discom. 193. 1893.
Unguicularíopsis Rehm, Ann. Myc. **7**: 400. 1909.

Apothecia small cupulate becoming expanded, usually occurring on other fungi, externally dark-colored, brownish, tomentose or

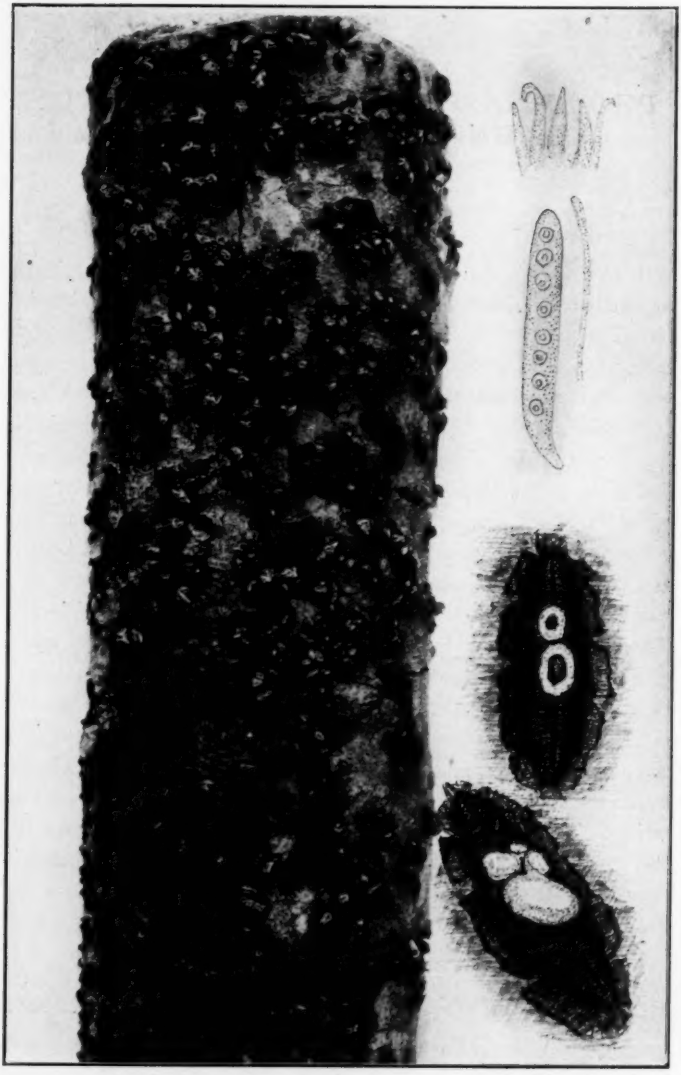

FIG. 1. *Mollisiella ilicincola.*

clothed with poorly developed hairs; asci clavate or cylindric, usually 8-spored; spores at maturity 1-seriate globose; paraphyses filiform, slightly enlarged above.

TYPE SPECIES, *Peziza ilicincola* Berk. & Br.

Mollisiella ilicincola (Berk. & Br.) Massee, British Fungus-Fl. **4**: 222. 1895

Peziza ilicincola Berk. & Br. Ann. Mag. Nat. Hist. III. **7**: 450. 1854.
Peziza hysterigena Berk. & Br. Jour. Linn. Soc. **14**: 106. 1873.
Peziza Ravenelii Berk. & Curt.; Berk. Grevillea **3**: 152. 1875.
Pseudohelotium ilicincolum Sacc. Syll. Fung. **8**: 304. 1889.
Lachnellula hysterigena Sacc. Syll. Fung. **8**: 391. 1889.
Cenangium Ravenelii Sacc. Syll. Fung. **8**: 568. 1889.
Mollisia ilicincola Phill. Brit. Discom. 193. 1893.
Unguicularioopsis ilicincola Rehm, Ann. Myc. **7**: 400. 1909.

Apothecia occurring in fasciculate clusters 1–2 mm. in diameter the individual apothecia irregularly cupulate often compressed from mutual pressure with the margins strongly incurved, externally furfuraceous whitish or brownish, with poorly developed hairs; hymenium concave, pallid-brown or purplish to rosy; asci cylindric to clavate, 8-spored, reaching a length of 40–50 μ and a diameter of 5–6 μ, 8-spored; spores usually 1-seriate, 4–5 μ in diameter; paraphyses filiform, slightly enlarged above.

Usually on other fungi, *Myriangium, Patellaria, Hysterium* and *Tryblidiella.*

TYPE LOCALITY: Europe.

DISTRIBUTION: North Carolina to Florida; also in Europe.

ILLUSTRATIONS: Ann. Mag. Nat. Hist. III. **7**: *pl. 16, f. 17.* Jour. Linn. Soc. **31**: *pl. 18, f. 15–18.*

THE NEW YORK BOTANICAL GARDEN.

EXPLANATION OF FIGURE

Left, photograph of a stick bearing apothecia of *Mollisiella ilicincola* on the hysterothecia of *Tryblidiella rufula.* Lower right, two hysterothecia much enlarged bearing apothecia. Above, drawing of an ascus with paraphysis and a clump of short hairs from the outside of the apothecium to the *Mollisiella.*

THE ASCOCARP AND ASCOSPORE FORMATION IN STEVENSEA WRIGHTII

B. O. Dodge [1]

(WITH 2 FIGURES)

During the course of our studies on the diseases of the prickly pear, *Opuntia*, we obtained several new species of parasites. The diseases produced by some of these fungi have been described in previous publications (Dodge, **1937, a, b**; **1938**). The three principal diseases studied by Wolf (**1912**) had not at that time been encountered on specimens from Florida, New Mexico, and Bermuda. More recently we found that a very rapid rather soft rot disease sometimes developed on the segments of *O. amophila* that had just come in from Florida. Within a week after the first appearance of the spots the segments became well rotted and hundreds of pustules were found breaking through the surface of the segment and developing masses of beautifully crescent-shaped 1-septate spores. The disease symptoms, as well as the spore characteristics, agreed with those of *Gloeosporium lunatum* (*Mycosphaerella Opuntiae*). As Wolf made a thorough study of this species, it is unnecessary to add our observations except to note that the progress of the disease is comparatively rapid. No other disease of *Opuntia* that we have studied so quickly destroys the segment.

We had not seen at that time any specimens showing fruiting bodies of *Perisporium Wrightii*, the second disease studied by Wolf. On this new Florida material, however, we found at first a few spots (FIG. 2, *F*), where numbers of coal-black fruit bodies were developing in a circle. At this time the bodies were too young to show spores of any sort. Somewhat later not only on this particular segment, but on other segments, a large number

[1] The writer is indebted to Mr. Frank Paladino, for assistance in the preparation of material for study, and to Miss Bass Guttman, for the drawings (Fig. 1), both of the Works Progress Administration.

of spots from five to ten millimeters in diameter developed. Where these were close together they coalesced more or less (FIG. 2, *E*). Crushed mounts of some of the older fruiting bodies showed that they were ascocarps containing a few large roundish asci with septate spores. These asci developed irregularly in a pseudoparenchymatous matrix (FIG. 1, *A–C*). Sections made of fixed material gave much the same picture as that figured by Wolf, so that there seems to be no question that our fungus is closely related to the one he described as *Perisporium Wrightii,* especially as the young spores usually are of a beautiful pale-violet or lilac color, later turning light-brown. They differed somewhat from those figured by Wolf in that many of them developed longitudinal septa. We were uncertain at first as to whether these longitudinal marks were real septa until examination was made of stained preparations, where it was shown that they were, thus making the spores muriform (FIG. 1, *D, E*).

In compiling a list of the fungi which have been reported on species of *Opuntia,* a list which was further elaborated and which will no doubt be published by Miss Josephine McAllister in connection with her studies of one of the new species of fungi which were found on this material, it was noted that F. L. Stevens (**1917**) had reported a species of ascomycete under the name "*Perisporiopsis Wrightii* (B. & C.) comb. nov." Trotter (Sacc. Syll. Fung. **24**: 261. 1926), finding later that the genus name *Perisporiopsis* F. L. Stevens was not available, created a new genus *Stevensea* with *S. Wrightii* (Berk. & Curt.) Sacc. as the type. Stevens says that the rare character of spores of violet color, turning to brown with age, seems to make it certain that the Porto Rican specimens and those studied by Wolf are co-specific. He pointed out, however, that the species could not be rightly regarded as belonging in the genus *Perisporium* because of the undoubted affinity with the Plectascineae, as shown by Wolf's drawings and his own specimens. He noted the additional character that the spores were frequently muriform.

It is interesting to find that W. C. Sturgis (Ellis collection Herbarium of The New York Botanical Garden) collecting at Grasman, Florida, in March 1893, found what he referred to as *Cookella?* on living stems of *Opuntia vulgaris.* His notes on

the packet are to the effect that the asci are " at first spherical, elliptical when mature, spores 21.4–29.9 × 10.7–12.8 μ, *hyaline.*" He has two clear-cut figures of spores showing longitudinal septa, one septum being diagonal. The fungus, according to a note on the packet added by Ellis, was identified by Ellis as " *Perisporium Wrightii* B. & C. No. 59, N. A. P. P. 56."

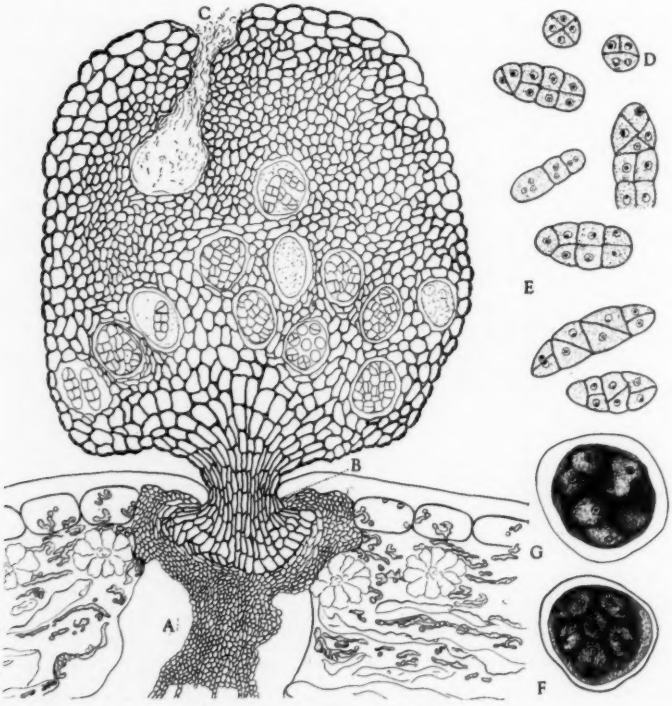

FIG. 1. *Stevensea Wrightii.*

It is further to be noted that Ellis and Everhart (**1892**), in their description of *Perisporium Wrightii,* say that the spores show longitudinal septa, and also that the ostiola of of the perithecia are papilliform and smooth, although in their characterization of the genus *Perisporium* the perithecia are said to open at length irregularly or with a circular mouth. There are certainly no or-

ganized ostiola in our material, otherwise we have been able to confirm the observations originally made by Ellis and also by Sturgis regarding the development of muriform spores. Our sections also show that the fungus cannot belong to the genus *Perisporium* because of the irregular distribution of the asci in a pseudoparenchymatous matrix such as characterizes the Myriangiaceae. This condition was accurately figured by Wolf and confirmed by Stevens, as noted. Even in old specimens the asci that develop are distinct, and not grouped together as though arising from some basal fertile area, an important point morphologically. Neither have we seen any asci that show definite stalks. At their origin they are more or less subglobose. Further elongation is due to the increase in length of the spores accompanied by a lessening of pressure from above due to disorganization of tissue to be noted later.

A few observations made in connection with these preparations may be of interest, although we are not putting them forward as a complete cytological account, merely noting that this material would certainly be excellent for studying the details of spore delimitation. We were unable to find any structure in the young ascocarps which could be looked upon as ascogonia. The fruiting bodies at first are made up of a mass of more or less undifferentiated pseudoparenchymatous tissue, the outer cells being somewhat more thick-walled (FIG. 2, *A*). As Wolf had noted, the structure develops at first in a substomatal cavity, then pushes up through to form the main part of the body superficially. One feature is the very characteristic foot-like structure just beneath the stomatal opening. This structure, expanded in the substomatal cavity, is embedded in a more delicately organized mass of tissue, the cells of which are much smaller and have thinner walls. The foot is connected to the perithecial body proper by a narrow isthmus of heavily carbonized tissue passing through the stomatal opening. Several upward growing layers of less heavily carbonized cells spread out fan-like from the stomatal opening to form the base of the ascocarp (FIG. 1, *A, B*).

The perithecium is globose, 180–250 μ. The foot structure is about 40–50 μ long and 34–40 μ wide as it enlarges in the substomatal cavity. At first the inner part of the perithecial struc-

ture is made up of homogeneous tissue and the one sees a few roundish asci developed rather above the center (FIG. 2, *A*). Older material (FIG. 2, *B, D*) shows a situation where many of the asci have matured their spores and discharged them through channels developed through the tissue above as the result of a disorganization of the cells. Most of our sections show a number of empty loculi above, with these irregularly progressing channels of disorganizing tissue leading to the surface. Below these loculi one always finds a number of asci with spores in various stages of development. Whether the development of asci is a continuous process or their development is seasonal, has not been determined. It looks, however, as though it were more or less progressive with interruptions due to unfavorable weather conditions. In the end the whole upper part of the fruit body will show the outer peridial wall cells broken away and the top of the cap irregularly bordered. When these fruit bodies dry out they close up at the top by a sort of infolding of the lacerated upper border.

One not infrequently sees very plainly the simultaneous delimitation of the eight spores in a stage in which the nuclei are very faintly stained, yet the central body at the beak and the astral rays extending outward and downward are very distinct ,as shown more or less diagrammatically in our figure 1, *F*. Soon the nucleus in each spore rounds up and it now stains heavily so that it is more readily distinguished. The spores are at first subglobose (FIG. 1, *G*), soon becoming elongated, short elliptical, with a single nucleus at the center. As the spore elongates further this nucleus divides and, usually, the first cross-wall is then laid down. We have not followed closely nuclear division step by step, but we have found all stages showing that occasionally a cell will have four nuclei before the cross-walls are definitely visible. The longitudinal septa may be laid down in one side of the spore and yet not be found on the opposite side, as shown in cross section of spores (FIG. 1, *D*). In certain cases these longitudinal septa are more or less oblique, reaching from one corner to that diagonally opposite (FIG. 1, *E*). They do not thicken, however, as much as the three transverse septa, so that in crushed mounts the transverse septa are more striking, the longitudinal ones at first appearing as mere lines and might readily be mistaken for vacuole separations.

Many spores show only eight nuclei, but we believe that not infrequently there is further nuclear division, although not necessarily a simultaneous division of all of the nuclei of the spore. It is rather difficult in tracing serial sections to be sure that one is always looking at the same spore and not at a spore directly underneath. The longitudinal septa are certainly much more numerous than would appear from crushed mounts. We have never seen a spore that has reached any considerable stage of maturity that does not show more than four nuclei. At maturity each cell of the spore contains a single nucleus. Certain views of stained sections would seem to indicate that more than three cross-walls are possible, but here again we are uncertain. We have never seen more than three in crushed mounts. Very likely three is the characteristic number of transverse sections. Spores vary in size considerably, especially do they vary in their width. The wall of the ascus is usually rather thick, as shown in our figures. While most of the ascus contents are included in the spores, there is always a definite layer of epiplasm surrounding the mass of spores just being delimited. A study of progressive degeneration of the inner perithecial matrix should prove interesting and of phylogenetic importance.

A thorough cytological study of the mechanics of the development of muriform spores has never been made. Some years ago while studying *Pleosphaerulina intermixta* we observed that the longitudinal septations very frequently were laid down only through one half of the cell so that in a cross-section of a spore the one part would be quartered while the other would still be in the form of a semi-circle. It was further observed where both halves of the spore show longitudinal septations, these did not necessarily meet at the same point, showing that septations of the various segments of the spore are laid down independently.

Most of the cytological work on species included in the order of Perisporiales has been done on species of the Erysiphaceae. The enormous size of the primary nucleus of the ascus of *Stevensea* and the method of spore delimitation might suggest to some a relationship to the Erysiphaceae, yet the general organization of the fruiting body is quite different and the features just mentioned may be only accidental parallelism. We usually think

of the asci of species of *Perisporium* as being arranged more or less in a way suggesting a development from a basal fertile tissue. Wolf says of the asci: "They are at first irregularly scattered in the pseudoparenchyma. At maturity a hollow receptacle containing a group of asci is present." We did not attempt to culture this species, but we were satisfied that it is what Stevens placed in his new genus *Perisporiopsis*. Our species is probably the same as that studied by Wolf, as noted.

The asci of our material are usually somewhat spherical 25–40 μ in diameter; some are rather elongated, 35–40 $\times$ 25–30 μ the ascospores are about 20–30 $\times$ 8–10 μ, agreeing very well with the measurements given by Sturgis and by Ellis & Everhart. Those asci measured by Wolf were "short obovate, 20–26 $\times$ 80–90 μ and the spores 24–30 $\times$ 10–14 μ." Stevens could not find ascospores in Wolf's specimens loaned by The New York Botanical Garden, and he does not give the measurements of spores from his own material.

We were interested to find that the material in Wolf's original packet at The New York Botanical Garden does show many asci and that after twenty-six years the young asci and ascospores still show the beautiful lilac color first noted by the authors of the species. Some of the mature asci are a little larger than we find in our material. Otherwise the characters are the same.

As to the place of this fungus in a classification system one thing is certain, it is not a *Perisporium* as Stevens first pointed out, and, furthermore, it should not be included in the Perisporiales. The asci are developed irregularly in the perithecial stroma. They have no particular orientation unless one can say that if they are elongated at all they are usually elongated upward. The substomatal foot structure is like that of *Stomatogene* figured by Theissen (**1916**), but the asci do not arise in a cluster from a basal fertile tissue; neither are the asci long clavate.

Cookella (Saccardo **1882**) in which genus Sturgis provisionally placed the fungus which he collected on *Opuntia* in Florida, may be closely related, but the perithecia of *Cookella* are applanate and the asci are said to be heaped together. The fruit bodies of our *Stevensea* are somewhat flattened when dry, but they are easily dislodged from the substratum showing the black spots

where the substomatal isthmus of tissue connecting with the foot structure has been broken off. Following the keys given us by Clements and Shear (**1932**) one always arrives at *Cookella* in the Myriangiaceae, although the ascocarps are not very membranous. Our sections (FIG. 2, *B–D*) certainly would suggest a discoid structure.

We have not seen specimens of *Cookella* but we have examined several collections of *Ascomycetella* Peck (**1886**), which Clements & Shear make a synonym of *Cookella*. There are certain similarities but *Ascomycetella* is not the same as *Stevensea* (*Perisporiopsis* Stevens) which Stevens says is unlike both *Meliola* and *Cleistotheca*. It is clearly one of the Myriangiaceae close to *Cookella* in the Clements & Shear keys.

The mechanics of spore delimitation found operating in *Stevensea* agrees with that described by Harper (**1896**) for the Erysiphaceae where the astral rays limit the sporeplasm to be included within the spore membrane. Several asci in our thick sections showed almost diagrammatically all eight spores being delimited.

In *Gelasinospora* (Dodge, **1937**) we have a certain definite departure from this method. The beak of the nucleus with its central body is embedded in the sporeplasm, and astral rays proceed outward in all directions, but not necessarily in an infolding layer. The amount of sporeplasm included in a spore is determined by the extension of this ray system and not so much by its infolding. The paired spindles of the third nuclear division persist until the spores are fully delimited. The striking orientation of these spindles along the long axis of the ascus is a feature that must be considered in a description of the mechanics of spore formation in *Gelasinospora*. Vacuolization does enter in spore delimitation, at least along the lines separating the spores.

Jenkins (**1934**) has recently described the process of spore formation in *Cordyceps*. He believes that vacuolization plays a prominent part. In personal correspondence regarding this point Dr. Jenkins has elaborated his idea still further and I am permitted to quote from his letter, which certainly is a distinct further contribution on the subject.

"Your paper (on *Gelasinospora*) brings to mind a point that

I tried hard to make clear in my paper, but which I now see may be subject to serious misinterpretation.

"The whole question seems to involve the concept conveyed by the word 'delimitation' . . . ; but perhaps I should have distinguished in my paper between the phenomena of spore initial delineation and spore delimitation. This seems as essential to a clear understanding of spore formation as are the terms mitosis and cleavage to cell division.

"From your illustrations (*Gelasinospora*) and mine (*Cordyceps*) it is evident that the symmetry of the spore initial is distinct beyond any question before astral ray activity can be demonstrated. At this stage, I am reasonably certain that a membrane does not separate the periphery of the spore initial from the remainder of the ascoplasm. The above described process might well be described as spore delineation, and it apparently arises through the innate energizing influence of the nucleus or nuclei, as the case might be.

"This probable explanation arises from the fact that it is impossible to conceive of a nucleus as an entity separate from its complement of cytoplasm. This viewpoint harmonizes, also with a condition described first by Doctor Higgins and later by myself in which the paired nuclei of the ascogonium and ascogenous hyphae were embedded in masses of cytoplasm, denser than the remaining cytoplasm of the respective structures. Later, cleavage sets in and whether through the agency of astral rays or vacuoles, the spore is delimited from the standpoint that it becomes separate from the ascoplasm. My observations on the process in *Cordyceps* did not agree exactly with the published viewpoint of Doctor Harper, but in going over the matter again in the light of broader experience, it seems that we may have differed only in degree."

This is perhaps not the occasion to discuss in detail the mechanics of ascospore formation, especially, the statements recently appearing in literature on the cytology of the ascus where it is claimed that ascospores without nuclei can be delimited. The idea being that almost any agglomeration of cytoplasm, definite masses of fatty substances, or other organized material in any ascus, is an ascospore, whether it has a nucleus or not. Wilson (**1936**) agrees that the astral rays have something to do with spore de-

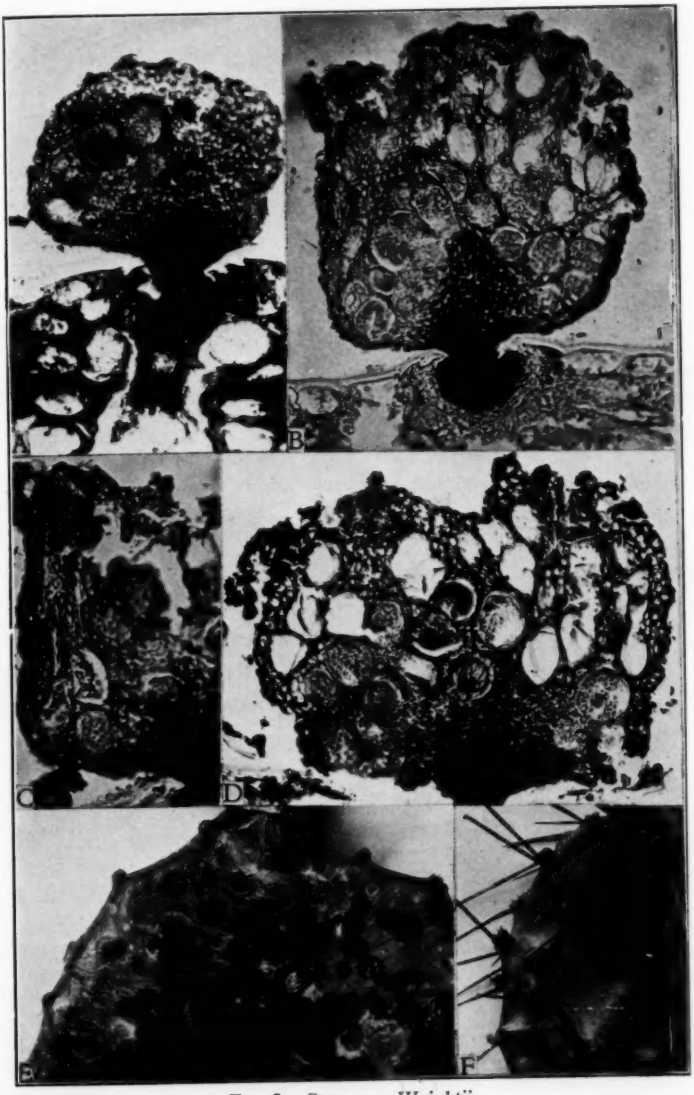

FIG. 2. *Stevensea Wrightii.*

limitation, but she also thinks she has akaryotic spores. She figures one ascus of *Peziza rutilans* with five spores, each of which has a nucleus. A sixth spore has three nuclei. This accounts for the eight nuclei. But there is, in addition, an "akaryotic" spore figured. Another ascus has eight normal spores, each with a nucleus. This same ascus has a ninth "spore" which lacks a nucleus. In *Neurospora tetrasperma* (Dodge **1936**) when both parents in the mating carry the recessive lethal, *d*, the asci, being homozygous, *dd*, do not cut out any spores because the eight nuclei degenerate. There are usually present certain bodies which are filled with fatty substances as indicated by their reaction to osmic acid fixation. They are variously shaped. In bleached preparations, these bodies are proved to be vacuolar; they are not spores. Furthermore, many asci without spores result from the mating when one parent carries the dominant lethal, *I* (Dodge, **1934**). But the ascus sac frequently persists and becomes indurated, brown and striated. Often such asci contain from one to fifty or more brownish, globose bodies. What they are is a question and one could insist that they are spores whether they have nuclei or not. There are some who think we have overemphasized the importance of astral rays in ascospore formation, and overlooked the role of vacuoles in this operation. It is furthermore possible that the nucleus with its beak elongated and capped with a centrosome from which proceed, in some cases at least, astray rays, is not the essential mechanism at all for free-cell formation. In other words ascospore delimitation may be purely a function of the sporeplasm, the inclusion of a nucleus while incidental, would be very advantageous, of course, in providing for the next generation. This new idea should be further supported by positive evidence, however, before being accepted. Jenkins in his paper, and in the quotation from his letter included above, has raised some fundamental questions and has shown very clearly the need for a further intense study of the cytology of the ascus.

THE NEW YORK BOTANICAL GARDEN.

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EXPLANATION OF FIGURES

FIG. 1. *Stevensea Wrightii.* Section of ascocarp, asci and spores. *A.* Sub-stomatal cavity containing mass of tissue with thin-walled cells in which is embedded the foot, *B*, which is composed of brown thick-walled cells. Vegetative hyphae in the intercellular substance sending haustorium-like contorted branches into the cell chambers. The main body of the ascocarp above is bordered by a peridial layer of cells whose outer walls are heavily carbonized. The inner part of the structure, except for the basal portion consisting of expanding upward-growing cell tiers, is composed of a pseudoparenchymatous mass of thin-walled cells. There are no indications of ascogenous hyphae from which the asci proceed. Several loculi with subglobose asci with spores are indicated. At *C* the opening in the stromatic

tissue developed through disorganization has allowed for the discharge of the matured spores from the loculus below. *D*. Cross sections of ascospores showing the manner in which longitudinal septa may be placed. *E*. Sections of other spores showing diagonal orientations of septa as well as some that are strictly longitudinal. Each spore has at maturity three cross-walls and each cell has one nucleus. One spore below shows a cell without a nucleus. This would have been present in the next section. *F*. Ascus showing seven spores being delimited. A beaked nucleus attached to the centrosome can be seen in each spore. Astral rays show very diagrammatically in the preparation. *G*. Ascus showing eight young elliptical spores fully delimited. Each spore has a single nucleus.

FIG. 2. *Stevensea Wrightii*. *A*. Section through young ascocarp the foot-like base of which is seen in the substomatal cavity; three young subglobose asci reaching maturity. The outer peridial wall of the ascocarp still intact. *B*. Old ascocarp showing the heavily carbonized foot structure and the upward growing rows of basal cells composing the sterile tissue serving as a stalk. A number of asci in various stages of maturity show in the lower part of the fruit body while above can be seen loculi with canals leading to the periphery and through which the mature ascospores have been discharged. The outer wall of the peridium above is much lacerated. *C*. At the left canals of disorganization extending from loculi from which the spores have just been discharged. The loculi still contain disorganized epiplasm. *D*. Two very distinct discharge canals leading from loculi below. Longitudinal septa can be seen in most of the ascospores in some of the other loculi. *E*. Portion of segment of *Opuntia amophila* showing black spots composed of many ascocarps. At the left some spots show where the ascocarps will appear later. *F*. Three infection spots each showing a ring of young perithecia.

NOTES AND BRIEF ARTICLES

Flora Italica Cryptogama

Fascicle 17 of Flora Italica Cryptogama, published by the Societa Botanica Italiana, has recently appeared. This fascicle is a continuation of the studies of the fungi of Italy, and comprises a volume of 440 pages devoted to a monograph of the Ustilaginales, including the Tilletiaceae, Graphiolaceae, and Ustilaginaceae, by Raphael Ciferri. The work is sparingly illustrated. The author is to be congratulated on his extensive contribution to our knowledge of the fungi of Italy.—F. J. Seaver.

A Case of Poisoning by Lepiota Morgani

On August 27th a resident * of East Lansing, Michigan, purchased a mess of mushrooms at the Lansing City Market. The vendor, from whom she had purchased mushrooms before for several years, assured her that they were safe, being " shaggy-manes." Being suspicious because of the greenish color of the gills the lady saved some specimens uncooked. Only she and her father-in-law partook of the cooked mushrooms, each eating not over a tablespoonful. Within two hours both were violently sick with intense vomiting and bowel movements, the stools being bloody. The victims became very pale but soon the skin took on a greenish-yellow color. Both experienced a feeling of extreme weakness which persisted several days. The attending physician gave hypodermic stimulants and did not consider the lady out of danger for 12 hours or her father-in-law for 24 hours after the onset of the symptoms. The uncooked specimens were submitted to the Department of Botany of Michigan State College and were beyond shadow of doubt *Lepiota Morgani* Peck, which is abundant in this vicinity nearly every Fall. The vendor when shown pictures (without English names) of several mushrooms including the true shaggy-mane (*Coprinus comatus*) at once selected the pic-

* Name on file in the author's records.

ture of *Lepiota Morgani* as being the mushroom she called "shaggy-mane."—ERNST A. BESSEY.

POISONING WITH CLITOCYBE ILLUDENS

Recently a practicing physician called at the writer's home with a paper bag full of a bright-yellow mushroom, stating that his patient had eaten of this mushroom and was very ill. He naturally wished to know the identity and nature of the suspected offender. It was readily identified as *Clitocybe illudens,* or the Jack-o-lantern fungus, well known to mycologists because of its attractive appearance and phosphorescent habits. The physician was informed that while this mushroom was usually listed as poisonous it was not one of the deadly forms, and his patient would not die.

A later report from this physician was as follows: "About one whole mushroom was eaten by the patient and immediately after ingestion of same, she felt a heavy sensation in the stomach, whereupon she induced vomiting by the usual household methods ridding herself after four or five attempts of all the mushroom she had eaten. At the time I saw her, patient was up and about but still nauseous and somewhat exhausted, most likely from the strain of vomiting, but pulse and respirations were quite normal. The vomitus at the time of my examination was clear. Throughout the day she felt somewhat tired and sleepy, but the following day felt perfectly well and has been well since."—FRED J. SEAVER.

THREE NEW BOLETES

Specimens here cited are to be found in the Herbarium of the Florida Agricultural Experiment Station, at Gainesville.

Ceriomyces flavimarginatus sp. nov.

Pileo convexo, 8 cm. lato, rubro-fulvo; tubulis flavo-virescentibus, sporis fusiformibus, flavo-brunneis, 14 × 4–5 μ; stipite flavo, reticulato, 3 × 0.8–1.5 cm.

Pileus convex, scattered, about 8 cm. broad; surface slightly viscid when moist, minutely tomentose, uniformly reddish-fulvous, margin even, entire, sterile, yellow below; context rather thin, of

mild flavor, white, unchanging, purplish under the cuticle; tubes reaching 1 cm. or more in length, depressed about the stipe, bright yellow with a greenish tint, mouths large, 1–2 to a mm., angular, the young marginal tubes remaining yellow and forming a distinct band; spores fusiform or boat-shaped, smooth, pale yellowish-brown, about 14 × 4–5 μ; stipe tapering upward, glabrous, pale yellow and delicately reticulate above, ferruginous at the very base, 3–5 × 1–2 cm.

Type collected by W. A. Murrill under an evergreen oak at Gainesville, Fla., June 14, 1938 (No. *F 16467*). After drying the cap has changed little in color, while the yellow stipe and marginal band show up in vivid contrast to the dark yellowish-green hymenium.

Ceriomyces subsensibilis sp. nov.

Pileo convexo, gregario, 7–10 cm. lato, ferrugineo-flavo ad livido-umbrino; sporis 14 × 4 μ; stipite flavo, reticulato, 4–6 × 1.5–2 cm.

Pileus broadly convex, gregarious, 7–10 cm. broad; surface smooth, minutely floccose-tomentose, uniformly ferruginous-flavous to livid-umbrinous, margin regular or somewhat lobed; context firm, whitish or cremeous, becoming pale-blue when wounded, sweet and nutty, 1–1.5 cm. thick; tubes decurrent, yellow to melleous or darker, becoming bluish-green when wounded, about 1 cm. long, mouths irregular, angular, entire, 1–2 to a mm.; spores elongate, fusiform, smooth, yellowish-brown, about 14 × 4 μ; stipe tapering downward, 4–6 × 1.5–2 cm., flavous above, reddish-brown below, blue where touched, coarsely reticulate, cremeous within, purplish at the base.

Type collected by W. A. Murrill on a lawn under a laurel oak in Gainesville, Fla., June 8, 1938 (No. *F 16374*). Also collected by the author under oaks in Gainesville, June 5 and 13, 1938 (*F 16483, F 16451*). The yellow part of the stem is sensitive to the touch but not the cap. The coarse reticulations over the stem are delicately traced but distinct.

Gyroporus pisciodorus sp. nov.

Pileo convexo, 8–12 cm. lato, tomentuloso, ochraceo-fulvo ad subumbrino, sapore grato; sporis hyalinis, 12 × 3–4 μ, stipite reticulato, 6–8 × 2–3.5 μ.

Pileus convex, thick, gregarious or cespitose, 8–12 cm. broad; surface dry, smooth, finely tomentose, ochraceous-fulvous to sub-

umbrinous, margin entire, even; context thick, white, unchanging, sweet and nutty, with a decided fishy odor; tubes depressed, long, white to fulvous, mouths at first covered with a floccose membrane, subcircular, entire, 1–2 to a mm.; spores elongate, smooth, multinucleate, perfectly hyaline in mass, about 12×3–$4\ \mu$; stipe thick, subequal or tapering downward, pallid and strongly reticulate above, furfuraceous and pale umbrinous below, solid, white above within and grayish below, 6–8×2–3.5 cm.

Type collected by W. A. Murrill near a live-oak and a pine at the Tung-oil Mill on the Newberry Road west of Gainesville, Fla., June 18, 1938 (No. *F 16258*). Having the appearance of *Tylopilus indecisus* (Peck) Murr., but with a pronounced fishy odor and absolutely hyaline spores. This characteristic odor develops more strongly in the process of drying; and, while bending over the electric oven, I could easily imagine myself tending a mess of big-mouthed bass.

NEW COMBINATIONS

For those using the older nomenclature the following new combinations are made:

CERIOMYCES FLAVIMARGINATUS = **Boletus flavimarginatus**
CERIOMYCES SUBSENSIBILIS = **Boletus subsensibilis**
GYROPORUS PISCIODORUS = **Boletus pisciodorus**

W. A. MURRILL.